The Yuquot Project
Volume 2

J.E. Muller — Geological Outline of the Nootka Sound Region, with Notes on Stone Artifacts from Yuquot, British Columbia

J.A. Donaldson — Lithology of Stone Artifacts and Associated Rock Fragments from the Yuquot Site

Anne M. Rick — Identification of and Biological Notes on Selected Bone and Tooth Artifacts from Yuquot, British Columbia

Louise R. Clarke and Arthur H. Clarke — Zooarchaeological Analysis of Mollusc Remains from Yuquot, British Columbia

Judith A. Fournier and John Dewhirst — Zooarchaeological Analysis of Barnacle Remains from Yuquot, British Columbia

Nancy M. McAllister — Avian Fauna from the Yuquot Excavation

Jerome S. Cybulski — Osteology of the Human Remains from Yuquot, British Columbia

Parks Canada Parcs Canada

43 History and Archaeology

88-04139/

History and Archaeology
43

The Yuquot Project
Volume 2

William J. Folan and John Dewhirst
Project Editors

---

3 **Geological Outline of the Nootka Sound Region, with Notes on Stone Artifacts from Yuquot, British Columbia**

J.E. Muller

15 **Lithology of Stone Artifacts and Associated Rock Fragments from the Yuquot Site**

J.A. Donaldson

23 **Identification of and Biological Notes on Selected Bone and Tooth Artifacts from Yuquot, British Columbia**

Anne M. Rick

37 **Zooarchaeological Analysis of Mollusc Remains from Yuquot, British Columbia**

Louise R. Clarke and Arthur H. Clarke

59 **Zooarchaeological Analysis of Barnacle Remains from Yuquot, British Columbia**

Judith A. Fournier and John Dewhirst

103 **Avian Fauna from the Yuquot Excavation**

Nancy M. McAllister

175 **Osteology of the Human Remains from Yuquot, British Columbia**

Jerome S. Cybulski

National Historic Parks and Sites Branch
Parks Canada
Environment Canada
1980

©Minister of Supply and Services Canada 1980.
Available in Canada through authorized bookstore agents and other bookstores, or by mail from the Canadian Government Publishing Centre, Supply and Services Canada, Hull, Quebec, Canada K1A 0S9.

En français ce numéro s'intitule Histoire et archéologie nº 43 (nº de catalogue R64-81/1980-43F). En vente au Canada par l'entremise de nos agents libraires agréés et autres librairies, ou par la poste au Centre d'édition du gouvernement du Canada, Approvisionnements et Services Canada, Hull, Québec, Canada K1A 0S9.

Price Canada: $11.25
Price other countries: $13.50
Price subject to change without notice.

Catalogue No.: R64-81/1980-43E
ISBN: 0-660-10717-1
ISSN: 0225-0101

Published under the authority
of the Minister of the Environment,
Ottawa, 1980.

The opinions expressed in these reports are those of the authors and not necessarily those of Environment Canada.

Geological Outline of the Nootka Sound Region, with Notes on Stone Artifacts from Yuquot, British Columbia

J.E. Muller

4 Abstract
5 Introduction
6 Brief Geological History
10 Lithic Composition of the Artifacts
13 General Character and Possible Source of Artifact Materials
14 References Cited

Abstract

In this paper I outline the geological history of the Nootka Sound region on the west coast of Vancouver Island, B.C., with some emphasis on glacial history and recent sea-level changes. The principal geological formations are briefly described. In light of this background, significant stone artifacts from the Nootkan village of Yuquot are discussed regarding lithic composition and, probably entirely local, geological provenience.

Submitted for publication 1979, by J.E. Muller, Geological Survey of Canada, Energy, Mines and Resources Canada, Vancouver.

Introduction

This brief contribution provides some geological background to the archaeological findings at Yuquot, Nootka Island, undertaken by the National Historic Parks and Sites Branch in 1966. I have carried out reconnaissance mapping on Vancouver Island since 1963 and I surveyed the Nootka Sound map area in 1968 and in 1971 (Muller et al. n.d.). The first part of this report deals with the general geological history of the region, and the second part with the lithology and probable geological provenience of the artifacts.

Brief Geological History

The following is an outline of known and inferred events in the geological history of Vancouver Island as they relate to the Nootka Sound area. These are discussed in much more detail in recent papers on Vancouver Island (Muller 1977) and the Nootka Sound area (Muller et al. n.d.). The general geology of the region is shown in Fig. 1. The rock-formations are in successive order, each with a more or less precisely known geological and absolute age, and each providing a record of a part of the region's geological history.

The oldest rocks are those of the Sicker Group, believed to be remnants of a volcanic archipelago of Late Paleozoic age, about 300 million years ago. They are lavas, tuffs, and water-lain sediments that have been metamorphosed considerably in succeeding ages. There is speculation that this volcanic terrane was several thousand kilometres south of its present position opposite the mainland of British Columbia. The volcanoes became extinct, were eroded down, and for considerable time there may have been a lowland where no new rocks were formed to record that time of geological history.

In Late Triassic time, about 200 million years ago, the old volcanic terrane was rifted apart and foundered well below sea level. New basaltic lava welled up in the rifts between the old rocks and covered them with many thousands of metres of volcanic rock. First it formed great masses of "pillows," ellipsoidal masses of congealed lava, on the seafloor, but later layered lavas were spread out over large areas that had emerged above sea level. The basaltic rocks and slightly younger limestone and shale deposited in shallow marine basins on the basalt form the Vancouver Group of rocks that underlies large parts of Vancouver Island. It is hypothesized that the rifting and volcanic eruptions signalled the beginning of the northward shift of the volcanic terrane from its original latitude (near Mexico ?) to its present position.

In the early part of the succeeding Jurassic epoch, about 180 million years ago, a new chain of volcanoes, built by the eruption of basaltic, andesitic, and dacitic lava flows, combined with minor marine sedimentary deposits to form the Bonanza Group of rocks. The volcanic eruptions were related to heating, recrystallizations, and partial melting of rock material many kilometres below the earth's surface. These processes are now known to occur wherever large parts of the earth's crust, called "plates," are moving towards one another, as happens in many places along the margin of the Pacific Ocean. The granitic and gneissic rocks, formed at depth by recrystallization during this event, are Island Intrusions and Westcoast Complex (Fig. 1).

In Middle Jurrassic time, about 160 million years ago, the volcanoes became extinct and were uplifted and subjected to erosion. In places they were submerged below sea level and covered by marine sediments of Late Jurassic and earliest Cretaceous age named the Kyuquot

Group. Much of the region may have stood above sea level until Late Eocene time, about 40 million years ago. About that time small granitic bodies, the Catface Intrusions (Fig. 1), were emplaced, possibly the feeders of another phase of minor volcanism. Later, parts of the west coast of Vancouver Island were submerged again, and sandstone, siltstone, and conglomerate of the Carmanah Group were deposited, mostly in rather deep water.

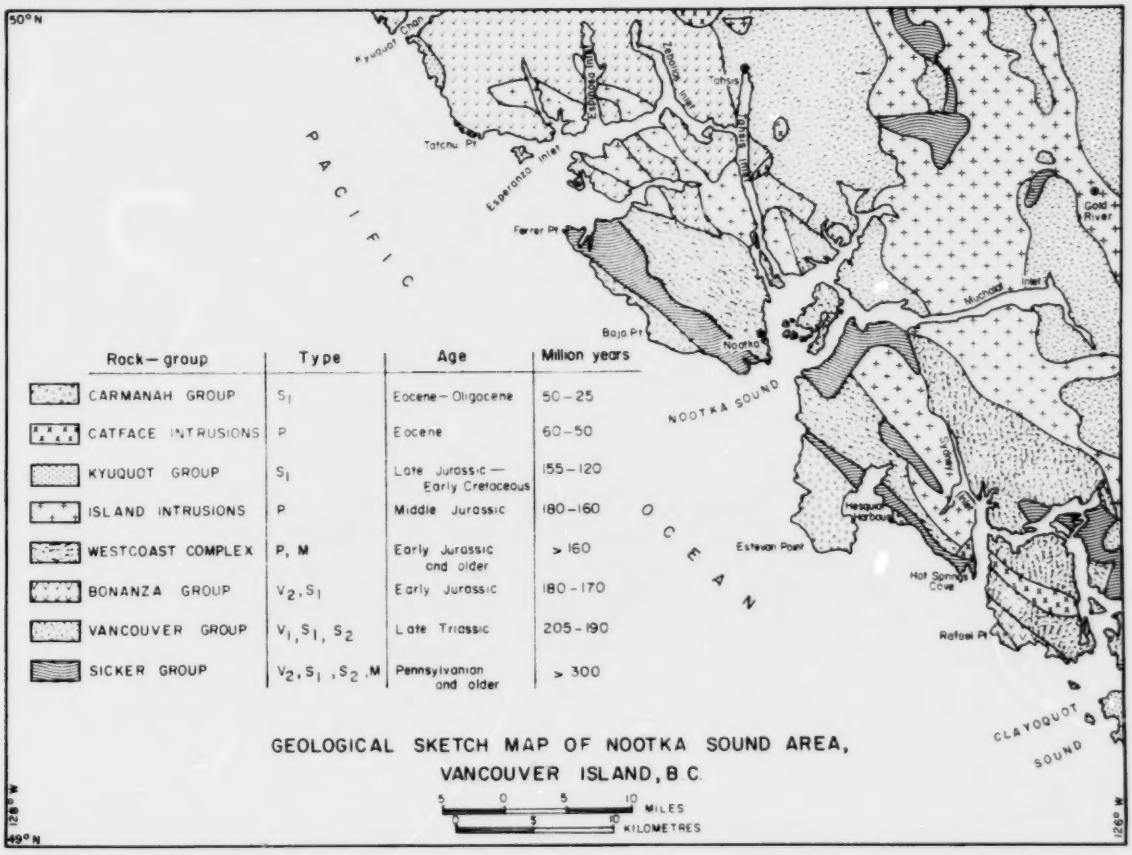

50°N
49°N
128°W
126°W
PACIFIC
OCEAN
Kyuquot
Tahsis
Tatchu Pt
Esperanza Inlet
Ferrer Pt
Bajo Pt
Nootka
NOOTKA SOUND
Gold River
Muchalat Inlet
Hesquiat Harbour
Estevan Point
Hot Springs Cove
Rafael Pt
CLAYOQUOT SOUND
Rock—group | Type | Age | Million years
CARMANAH GROUP | S_1 | Eocene—Oligocene | 50–25
CATFACE INTRUSIONS | P | Eocene | 60–50
KYUQUOT GROUP | S_1 | Late Jurassic—Early Cretaceous | 155–120
ISLAND INTRUSIONS | P | Middle Jurassic | 180–160
WESTCOAST COMPLEX | P, M | Early Jurassic and older | > 160
BONANZA GROUP | V_2, S_1 | Early Jurassic | 180–170
VANCOUVER GROUP | V_1, S_1, S_2 | Late Triassic | 205–190
SICKER GROUP | V_2, S_1, S_2, M | Pennsylvanian and older | > 300
GEOLOGICAL SKETCH MAP OF NOOTKA SOUND AREA, VANCOUVER ISLAND, B.C.
5 0 5 10 MILES
5 0 5 10 KILOMETRES

Fig. 1. Nootka Sound area, Vancouver Island, B.C. Sedimentary rocks - laid down at earth's surface, usually in water - S_1: clastic sediments, composed of debris of older rocks; shale, sandstone, conglomerate. S_2: carbonate sediments, precipitated in water; limestone. Volcanic rocks - formed at earth's surface from hot lava; flows, breccias (broken lava), and tuff (consolidated volcanic ash) - V_1: mainly basaltic composition. V_2: basaltic, dacitic, and rhyolitic composition. Plutonic rocks - formed by cooling and crystallization of molten and semi-molten rock at several thousand metres depth - P: quartz diorite, granodiorite, granite. Metamorphic rocks - formed by recrystallization of existing rocks at depth under heat and/or pressure - M: schist, gneiss, migmatite.

The geological record thus shows several episodes of volcanism, plutonism (subterranean heating and cooling with crystallization of granitoid rock), and submergence with attendant formation of marine sediments. In addition, rupturing of the rocks occurred several times due to relative shifting of parts of the earth's crust, and small and large faults were formed. Many valleys and inlets of the sea are located on faults that are zones of easily shattered rock.

Finally, in the Pleistocene Epoch, the region was covered, like most of British Columbia, by large expanses of ice that advanced and retreated several times. Levels of maximum glaciation are readily determinable from smooth, ice-worn rock surfaces, whereas non-glaciated mountaintops ("nunataks") are recognizable by steep sides and pinnacled peaks. During the maximum "continental" glaciation the icecap was continuous from the Coast Mountains across the Strait of Georgia where it stood at least 1200 m (4000 ft.) above present sea level and sloped down across Vancouver Island to about 600 m (2000 ft.) over Nootka Island. Traditionally this maximum glaciation is equated with the maximum of the Fraser Glaciation, the Vachon Stade, that occurred about 15,000 years ago (Armstrong et al. 1965; Mathews et al. 1970). I favour a greater age for this maximum glaciation, at least as old as the Salmon Springs Glaciation (Early Wisconsin glacial age), that occurred more than 37,000 years ago and is known to have been much more extensive in Puget Lowland and Olympic Mountains than the Fraser Glaciation (Late Wisconsin glacial age). This interpretation does not appear to be in conflict with available data and was recently proposed by Fladmark (1975). He suggested that major portions of the coast were ice-free throughout the Fraser Glaciation, thereby raising the theoretical possibility that man could have lived in these areas for over 40,000 years.

At a later stage of "mountain glaciation" separate icecaps occupied the high mountain regions, and long valley glaciers issued from these. Ice streams from the Coast Mountains coalesced and formed a huge piedmont glacier that filled the Georgia Depression to about 500 m (1500 ft.) above present sea level but did not extend across the central Vancouver Island Ranges. Instead, local icecaps occupied three centres on these mountains, and valley glaciers issued from these in various directions. In the Nootka Sound area one valley glacier entered Gold River valley from the north and terminated a few kilometres south of the present townsite. At that time no ice was present on Nootka Island or in Nootka Sound. A similar valley glacier on southern Vancouver Island was the "Cowichan Ice tongue," which according to Halstead (1968) occupied Cowichan Valley less than 19,000 years ago. Although many writers consider this stage of piedmont and valley glaciation as merely a waning stage of maximum Fraser Glaciation, I prefer to interpret this stage as the maximum Vachon Stade that occurred about 15,000 years ago. More recently small high alpine glaciers, a few kilometres long, have from time to time issued from mountain tops and carved out small depressions, now usually occupied by tarn lakes.

Deglaciation occurred after the Fraser Glaciation maximum, 15,000 years B.P., but is inferred to have been temporarily halted during the Sumas advance, 11,500 years B.P. During deglaciation sea level fluctuated considerably as a result of three different and more or less

independent factors: 1) worldwide eustatic level rose as continental icecaps retreated, releasing water to the oceans; 2) areas covered by ice during maximum glaciation had been depressed isostatically and rose (in respect to a fixed point at the earth's centre) after the iceload was removed; 3) certain areas experienced vertical movements as a result of tectonic events, unrelated to glaciation or deglaciation. During early deglaciation a eustatic rise in sea level, well ahead of isostatic uplift, resulted in high sea levels in the Strait of Georgia area. Mathews (1970) and others concluded on the basis of carbon-14-dated marine deposits that sea level rose to 150 m (500 ft.) on eastern Vancouver Island and to 75 m (250 ft.) near Victoria, about 12,500 years ago. Elevated marine terraces near Tofino, 75 km southeast of Yuquot, are possibly of the same period. Likewise, the coastal plain bordering Nootka Island to the southwest up to a level of about 60 m (200 ft.) might represent a postglacial coastal shelf.

According to Mathews (1970) and others sea level was lowered to near present level during the Sumas readvance, about 12,000 B.P., rose after the Sumas maximum, and was depressed once more to at least 10.6 m (35 ft.) below present level about 8000 years ago.

Mathews et al. (1970), Fladmark (1975), and Clague (1975) report that sea level rose gradually until it reached present level at about 4000 B.P. From then on ancient sea levels are determined largely in relation to the position of archaeological sites. The Montague Harbour site on Galiano Island includes material 3160$\pm$ 130 years B.P. below the present high tide level (Mitchell 1971: 61, 63, 67), which suggests relative rise of sea level since that time. On the other hand, the Yuquot site may have been lower than present at that time, for Zone I deposits, about 6 m above present mean sea level, appear to be waterworn (Dewhirst 1980). Such slight differential movements are readily explained by tectonic adjustment, for the coastal regions of British Columbia and many other parts of the Pacific margin are known to be tectonically active zones.

Lithic Composition of the Artifacts

Most significant lithic artifacts from the Yuquot excavation were submitted to me for non-destructive identification of the material. The common procedure of making thin sections of a rock specimen for microscopic examination could therefore not be used, so the visual identifications can be qualified only as rough field classifications. The rock types distinguished in the archaeological specimens are briefly described and assigned letter abbreviations. Table 1 lists, by artifact type and catalogue number, each specimen examined and its abbreviated lithic identification. For excavation proveniences, discussion, and illustrations of the specimens see Dewhirst 1980.

Basaltic Rocks

Basalt is, on a worldwide basis, the most common volcanic rock. It occurs mostly as lava, but occasionally as breccia and tuff, which are comminuted fragments of lava consolidated into coarse or fine-grained rock. They are generally dark-coloured rocks composed of a mesh of crystallites of plagioclase feldspar, pyroxene, minor metallic oxides, sulphides, and volcanic glass. The grain size of basaltic rocks may be distinguished as follows: fine grained, less than 1.0 mm but visible to the naked eye; and aphanitic, or invisible to the naked eye. Geologists make a distinction between basalt and andesite. The latter is a more siliceous rock, and its plagioclase contains more sodium. This distinction cannot be made in a field classification, therefore all dark-coloured basalt-like rocks have been so named.

BA Basalt, aphanitic.

BF Basalt, fine grained.

BM Basalt, medium grained.

BPM Basalt porphyry; one generation of medium-grained minerals ("phenocrysts" of feldspar and augite) in a fine-grained matrix.

BFAm Basalt, fine grained, amygdaloidal (with vesicles filled with secondary minerals, in this case quartz and epidote).

BPF Basalt, prophyritic fine grained; contains phenocrysts of feldspar $\pm$ 1.0 mm in size.

BGF Basalt, glomeroporpyritic, fine grained; phenocrysts in clusters.

BTA Basaltic tuff, aphanitic to fine grained (fragments of basaltic minerals and glass deposited in air or water).

BTM Basaltic tuff, medium grained.

AqT Aquagene tuff; consists mainly of devitrified glass lobules formed under water by chilling of lava droplets.

Dacitic Rocks

Dacites occur also as lava, breccia, or tuff, and are intermediate in composition between basalt and rhyolite. They contain more silica and less metallic elements than basalt. In the field they are light-coloured, yellowish to reddish grey rocks.

D	Dacite.
DF	Dacite, fine grained.
DTF	Dacite tuff, fine grained.
DTM	Dacite tuff, medium grained.

Sedimentary Rocks

FAr	Feldspathic argillite; a well-indurated clay stone with visible feldspar fragments.
FGM	Feldspathic greywacke, medium grained; a sandstone composed of mainly feldspar and less volcanic rock fragments in a claystone matrix.
J	Jet; a lightweight carbonaceous material similar to brown coal or lignite, that can be polished.

Table 1. Gross Lithological Classification of Selected Yuquot Artifacts

Celts

a) Round-Polled Narrow Celts

1T2B33A-2776x	BF
1T1C27-1579x	BTM
1T2C23-1171	BTA
1T1G24-2578	BA
1T1H22A-2768	BGF
1T2H22-2482	BTM
1T1X1-3318	BF

b) Flat-Polled Narrow Celts

1T2A26-1309	BPM
1T3A8-254x	BF
1T2C5-551x	BTM
1T1E4A-1307	BGF
1T1E4A-1312	BGF
1T1E23-2375	BGF
1T1H20B-3422x	BGF
1T1J13-2423x	BTM
1T1X1-1199	BTA

c) Broad Celts

1T2B2A-113x	BTM
1T2E16-2024x	BAmF
1T1G28-2679	AqT
1T2G12-1545x	FAr

d) Other Celts

1T2D12-2363x	BF
1T1E5-1328	BTA
1T1E25-2456	AqT
1T1H20A-2700	BPF
1T1J21B-2617	BTM
1T2J7-1532	BTM

Flaked-Stone Wedges

1T2C19-804x	BA
1T1E23-2978x	BGF
1T1E24A-2980x	DTM

Worked Stone

a) Probable Unfinished Narrow Celts

1T2B5-204x	BF
1T1E21-2291x	BPM
1T1H19B-2642	BTA

b) Sawed Stone

1T1C13A-852	BTA
1T1C16A-868	BF
1T1E13-2301	BTA

c) Split and Ground Stone

1T1C19A-912	BPF
1T2F14A-2323	BA
1T1G16-2263x	BA
1T2K7-1780x	DTM

Abrasive Saws

1T1B14-2822x
1T1D19-2954x
1T1F11-1972
1T1H68-3407x
1T1M6-3539x
1T1X1-3552
→ FGM

Rectangular Abraders and Plane Abraders

1T3A27-3857x
1T1B19-3861x
1T1B27-3865x
1T1C29-3864x
1T2E5-3859x
1T2G10-3862x
1T1J9-3866x
1T1M7-3860x
1T1M7-3863x
→ FGM

Abrasive Materials

1T1B27
1T2B19
1T2F9B
1T2F24
1T1H10
1T2H18A
1T2K4A
1T2L8
→ FGM

Cone Abrader

1T2K7-1795	FGM

Rectangular Abrader

1T3C9-409	BF

Hand Maul

1T2F3A-1694	BM

Fish Knife

1T2F13A-2318	BTA

Stone Fish-Hook Shanks

a) Rectangular-Based Stone Shanks

1T3A15-884x	D
1T1C13-842	BA
1T2D4C-2224x	BA
1T2L8-1991	DTF
1T2M8-2558	DTF

b) Bent-Stemmed Stone Shanks

1T1H7B-1487	FAr
1T2H7-1877x	DTF
1T1X1-3551	DTF

c) Other Stone Shanks

1T2E5-2787x	BA
1T2E7-1277x	DTF
1T1F8-1275	BTA
1T1F8-1286	BTA
1T2H6C-1864	FGM
1T1M3-1899x	DTF
1T1X1-3310	FAr

Pendant

1T1G11-1903x	J

Possible Labret Fragment

1T1E29D-5472x	DTF

Possible Point of Composite Club

1T2F29B-2508x	DTM

General Character and Possible Source of Artifact Materials

It is quite apparent that the tool makers selected specific rock types for certain purposes. Thus, only the Tertiary greywacke sandstones of the west coast of Nootka Sound were used for abraders. For this purpose they would be most suitable. They are the only rock in the vicinity containing a considerable percentage of quartz grains to serve as a grinding component. For the manufacture of small hand tools, the fine-grained or aphanitic massive rocks were apparently the most suitable. They were used especially for making cutting edges or shaping of small fish-hook shanks. All fish-hook shanks, small pebble wedges, and celts are made of aphanitic and fine-grained rocks. Only a large hand maul (1T2F3A-697) and a large flat-polled celt (1T2A26-1309) are made of a coarser grained basaltic material. The fine-grained volcanic rocks (including a few examples of feldspathic argillite) are probably mostly derived from the Jurassic Bonanza Group, extensively exposed on the shores of Esperanza and Tahsis inlets. Perhaps some of the volcanic rocks are derived from the Sicker Group, exposed much nearer to Friendly Cove, although these rocks are generally much more metamorphosed than the material of the artifacts appears to be.

The material of the pendant appears to be jet, with a characteristically low specific gravity of only 1.3. Jet is a hard variety of lignite that has been used in jewellery since prehistoric times. In England jet is well known from Whitby, Yorkshire, where it occurs in Jurrassic shales. It is tempting to speculate that the jet of the Yuquot pendant was obtained from the sediments of the Jurassic Kyuquot or Bonanza Groups. Fossil plants were found in the former by Jeletzky (1950, 1954) and the occurrence of small coaly lenses, some with the consistency of jet, is probable in that geological environment.

References Cited

Armstrong, J.E. et al. 1965. Late Pleistocene Stratigraphy and Chronology on Southwestern British Columbia and Northwestern Washington. Geological Society of America Bulletin, Vol. 76, No. 3, pp. 321-30.

Clague, J.J. 1975. Late Quaternary Sea Level Fluctuations, Pacific Coast of Canada and Adjacent Areas. Geological Survey of Canada Paper 75-1C, pp. 17-21. Ottawa.

Dewhirst, John. 1980. The Indigenous Archaeology of Yuquot, a Nootkan Outside Village. National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, No. 39, The Yuquot Project, Vol. 1.)

Fladmark, Knut R. 1975. A Paleoecological Model for Northwest Coast Prehistory. Archaeological Survey of Canada, Paper no. 43, National Museum of Man, Ottawa.

Halstead, E. Carl. 1968. The Cowichan Ice Tongue, Vancouver Island. Canadian Journal of Earth Sciences, Vol. 3, No. 6, pp. 1409-15. Ottawa.

Jeletzky, J.A. 1950. Stratigraphy of the West Coast of Vancouver Island Between Kyuquot Sound and Esperanza Inlet, British Columbia. Geological Survey of Canada Paper 50-37. Ottawa.

---. 1954. Tertiary Rocks of the Hesquiat-Nootka Area, West Coast of Vancouver Island, British Columbia. Geological Survey of Canada Paper 53-17. Ottawa.

Mathews, W.H., J.G. Fyles and H.W. Nasmith. 1970. Postglacial Crustal Movements in Southwestern British Columbia and Adjacent Washington State. Canadian Journal of Earth Sciences, Vol. 7, pp. 690-702. Ottawa.

Mitchell, Donald H. 1971. Archaeology of the Gulf of Georgia Area, a Natural Region and Its Culture Types. Syesis, Vol. 4, Supplement 1. Victoria.

Muller, J.E. 1977. Evolution of the Pacific Margin, Vancouver Island, and Adjacent Regions. Canadian Journal of Earth Sciences, Vol. 14, No. 9, pp. 2062-85. Ottawa.

Muller, J.E., K.E. Northcote, and B.E.B. Cameron. n.d. Geology and Mineral Deposits of Nootka Sound Map-Area, Vancouver Island, British Columbia. Geological Survey of Canada Memoir.

Lithology of Stone Artifacts and Associated Rock Fragments from the Yuquot Site

J.A. Donaldson

16 Abstract
17 Introduction
18 Method of Study
19 Rock Types Identified
22 References Cited

Abstract

The lithic identifications of 63 selected artifacts and materials from Yuquot, B.C., are presented. Most artifacts are abraders of soft-grained sedimentary rocks. They would likely have been suitable for fine polishing or honing.

Submitted for publication 1979, by J.A. Donaldson, Department of Geology, Carleton University, Ottawa.

Introduction

A collection of 63 selected stone artifacts and associated materials from the midden at Yuquot, Nootka Sound, B.C., is herein classified lithologically. Most lithologies noted by J.E. Muller in his study of other selected artifacts from the same site (Muller 1979) occur in the present collection, as well as several additional rock types. Most specimens are abrasive artifacts or raw materials probably collected for that purpose.

Method of Study

For lithological identification, fresh rather than weathered surfaces are preferable, and accurate assessment of mineralogy commonly requires examination of rock sections by means of the petrographic microscope. Although bedrock specimens can be examined routinely in this way, the non-destructive examination of artifacts must be restricted to available (commonly worked or fractured) surfaces. Accordingly, specimens of the Yuquot collection were examined by means of a binocular microscope, and lithologic designations should be regarded as tentative. More rigorous study within the limitation of non-destructive examination would include direct comparison with the collection studied by Mulier.

The specimens range from unequivocal artifacts to pebbles and rock chips which appear to show little evidence of modification by man. However, specimens in the latter category could well have been used because of a favourable natural shape (e.g. prolate cobbles for hammer stones), or may have been collected as potential material for working, but escaped being so used, possibly because of selective discard at the site.

Rock Types Identified

The lithologies identified are listed in Table 1. The letter code of Muller (1979) has been used for apparently similar lithologies, and a similar code has been devised for the additional lithologies. These codes are used in the specimen tabulation (Table 2) to identify the lithologies. The artifact types and proveniences are discussed by Dewhirst (1980).

An interesting characteristic of the present collection is the abundance of relatively soft fine-grained sedimentary rocks, most of which show signs of use as abraders or whetstones. Of particular interest is specimen 1T1H20B-3623x, a rectangular abrader of calcareous mudstone with a thin tabular layer of calcite on one side. Although calcite is a soft mineral (H=3 in the Mho scale of hardness), the calcite layer has been preferentially worn. It now has a distinct "hollow ground" aspect, with concave relief of about 2 mm. The utility of similarly ground slabs of quartz and feldspar rich tuffaceous siltstones is clear, but for what would a soft calcite abrader be used? Could it have been used for polishing carved wood or shell objects? Was the slab itself abraded to serve some non-abrasive function?

The tabular form of most siltstone and mudstone slabs can be readily explained in terms of bedding intersected by joints perpendicular to bedding. Some of the tabular slabs (rectangular abraders) display the added characteristic of having one face slightly "hollow ground" as described above for the calcite layer. Even though these mudstones and siltstones are soft because of a moderate content of carbonate and/or clay minerals, they would be reasonable materials for polishing because of their content of quartz and feldspar grains. However, these slabs (rectangular abraders), unlike the specimen with calcite on one side, are relatively homogeneous throughout.

Table 1. Lithologies in the Yuquot Collection

(i) Lithologies common to the collection studied by J.E. Muller

BA	Basalt, granitic
BF	Basalt, fine grained
BPF	Basalt, porphyritic, fine grained; phenocrysts of feldspar
BGF	Basalt, porphyritic, fine grained; feldspar phenocrysts in clusters
BTA	Basaltic tuff, aphanitic
BTF	Basaltic tuff, fine grained
BTM	Basaltic tuff, medium grained
DTF	Dacite tuff, fine grained
DTM	Dacite tuff, medium grained
I	Ignimbrite (welded siliceous tuff)

(ii) Additional Lithologies

MB	Metabasalt, very fine grained, massive; laced with calcite veinlets
A	Amphibolite, very fine grained; distinct lineation; calcareous; greyish black
SL	Slate, aphanitic to fine grained; greenish grey to black; crude slaty cleavage
SCH	Schist, medium grained, well foliated; quartz and biotite rich
S	Siltstone, light buff to grey; massive to faintly laminated
CS	Calcareous siltstone, light grey to tan; thin tabular laminations common
TS	Tuffaceous siltstone, light to dark grey; massive
AS	Argillaceous siltstone, grey, massive to faintly laminated; mottled texture
M	Mudstone, massive to well laminated; light grey to buff weathered surface
CM	Calcareous mudstone, yellow, buff, or tan weathered surface; laminated; possibly dolomitic
L	Limestone, very fine grained, greyish white; faintly laminated.

Table 2. Lithic Identifications of Yuquot Artifacts

Rectangular abraders	
1T1E5A-4327x	
1T1G19-5026x	M
1T2H17B-3627x	
1T1M7-3540x	
1T1A19-5103x	
1T2B20-3606x	
1T2C20A-1133	
1T2D21-2685x	
1T1G4-4252x	CM
1T1H20B-3623x	
1T1J13-4513x	
1T1M2B-4004x	
1T1M3-3869x	
1T1A16B-3641x	
1T2E17-3330x	
1T1F14C-3603x	
1T2F5A-3597x	S
1T2H4-4022x	
1T2H18B-4309x	
1T2L11-3587x	
1T1M7-1996	
1T1C20A-4583x	
1T1H19A-2640	CS
1T1H6A-3958x	
1T1K11A-3592x	
1T2C21-1913x	
1T2G7C-4804x	
1T2G20-3972x	
1T2H6-1856x	
1T1J6-3604x	TS
1T2J9-2068	
1T1X1-3634	
1T1X1-3658	
1T1X1-4051	
1T2B11-3662x	
1T2E18-3625x	AS
1T1G11A-3647	
1T2A17-3670x	L
1T2G24A-2767	BPF
1T1J11-3596x	BTF
1T1J20B-3591x	BTA
1T2C15-774	
1T1G13-1945	DTF
1T1J5-5263x	A
Bar abrader	
1T1D14-4543	CM
Grooved abrader	
1T1G16A-868	CS
Plane abrader	
1T1B12-5025x	BTF
Prism abrader	
1T2H9-4039x	S
Abrasive saws	
1T3C17B-5091x	DTM
1T1X1-3324	SL
Cobble spall plane	
1T2E4-3635x	DTF
Pebble pendant	
1T1A3-216x	BTA
Cylindrical bead	
1T1H3-1369x	TS
Possible paint or decorative materials	
1T2A18-5092x	AS
1T2F23-5298x	SCH
Collected material	
1T1X1-3308	SL
Uncompleted celts	
1T3B13A-3638x	MB
1T2F24-3666x	BF
Celt fragment	
1T1H5-1345	BA
Cobble hammer	
1T1B3A-3673x	I
Flaked-stone wedges	
1T2B30-3639x	BGF
1T1J22B-3674x	BF
Chipped flake	
1T1E29B-3677x	BTM

References Cited

Dewhirst, John. 1980. The Indigenous Archaeology of Yuquot, a Nootkan Outside Village. National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, No. 39, The Yuquot Project, Vol. 1.)

Muller, J.E. 1979. Geological Outline of the Nootka Sound Region, with Notes on Stone Artifacts from Yuquot, British Columbia. Manuscript on file, National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, The Yuquot Project, Vol. 2.)

Identification of and Biological Notes on Selected Bone and Tooth Artifacts from Yuquot, British Columbia

Anne M. Rick

24 Abstract
25 Introduction
27 Species Identifications
27 Dog or Wolf (*Canis* sp.)
27 Black Bear (*Ursus americanus*)
27 Raccoon (*Procyon lotor*)
28 Northern Fur Seal (*Callorhinus ursinus*)
29 Northern Sea Lion (*Eumetopias jubata*)
30 Harbor Seal (*Phoca vitulina*)
31 Northern Elephant Seal (*Mirounga angustirostris* ?)
31 Other Sea Mammal Artifacts
32 Cervidae, Species Undetermined
32 Black-Tailed Deer (*Odocoileus hemionus*)
34 Unidentifiable Mammal Teeth
34 Unidentifiable Bone Awls
36 References Cited

Abstract

Examination of a small collection of bone and tooth artifacts from Yuquot provided data on sources of raw materials for artifact production and on modification methods. Most worked teeth came from sea mammals, particularly the northern fur seal (Callorhinus ursinus), whereas the majority of bone artifacts were made from black-tailed deer (Odocoileus hemionus) elements. Although only 181 artifacts were studied, they yielded considerable biological information on age, sex, number of individuals present, and ecology of the species represented.

Submitted for publication 1973, by Anne M. Rick, Zooarchaeological Identification Centre, National Museum of Natural Sciences, Ottawa.

Introduction

The Nootkan village of Yuquot, at Nootka Sound on the west coast of Vancouver Island, was the site of an extensive archaeological excavation in 1966 by the National Historic Parks and Sites Branch. Directed by William J. Folan and assisted by John T. Dewhirst, a section of the village midden was excavated to a maximum depth of 18 ft., yielding evidence of at least 4300 years of human occupation. Four major stratigraphic zones, each including two or more substrata, have been distinguished: Zone I, 2300 B.C. - 1000 B.C.; Zone II, 1000 B.C. - A.D. 800; Zone III, A.D. 800 - 1790; and Zone IV, A.D. 1790 - 1966 (Dewhirst 1980). Zones I, II, and III are prehistoric: Zone IV contains historic deposits.

Various individuals have undertaken analyses of the faunal remains from Yuquot. A collection of 181 bone and tooth artifacts was submitted to the Zooarchaeological Identification Centre, National Museum of Natural Sciences, in spring 1973 for species identification and comments on extent of modification and biological significance. These items were part of a larger number of artifacts, but only specimens thought to be possibly identifiable were submitted. Of the 181 specimens, 39 of 48 teeth and 66 of 133 bones could be identified (Table 1). Identified material is discussed in detail, whereas unidentifiable material has

Table 1. Summary of Yuquot Faunal Material*

Species	Teeth	Bones
Canis sp.	1	
Ursus americanus	2	
Procyon lotor		1
Callorhinus ursinus	17	
Eumetopias jubata	5	1
Phoca vitulina	8	
Mirounga angustirostris (?)	1	
Sea mammal+	5	6
Odocoileus hemionus		57
Cervidae+		1 (antler)
Mammal teeth, unidentifiable	9	
Mammal bone, unidentifiable		58
Bird bone, unidentifiable		8
Class uncertain		1
	48	133
Total	181	

* Species categories include probable identifications.
\+ Not further identifiable.

been listed with little or no comment at the back of this report. Most unidentifiable land mammal bone fragments must have come from medium to large animals; probably most of them are deer.

This collection is of special interest because of the pinniped teeth which it contains. Fur seals and sea lions exhibit pronounced sexual dimorphism and this is reflected in the size and shape of their canine and upper third incisor teeth as well as in differences in body size and weight. Thus an isolated canine can reveal the sex of the animal from which it came. In addition, there have been a number of studies made on age determination of pinnipeds based on teeth, especially the canines, so that approximate age as well as sex could be deduced from many of the tooth artifacts. For more extensive descriptions of all identified artifacts from this collection see Rick 1973. The skeletal reference collection of the Zooarchaeological Identification Centre (ZIC) and other skeletal collections within the National Museum of Natural Sciences (NMNS) were used during this study.

Species Identifications

Dog or Wolf (*Canis* sp.)

Material. 1T2B16A-5297x

Discussion. A single right upper third incisor belongs to this genus. The occlusal surface of the crown is considerably worn, and there is a diagonal groove across the buccal-distal crown surface; these are both probably the result of natural wear.

This tooth is from a large dog (*Canis familiaris*) or a wolf (*C. lupus*).

Provenience. The specimen was found in Zone IIIc.

Black Bear (*Ursus americanus*)

Material. 1T3N6-1980x
1T1X1-3015

Discussion. Two artifacts are from bear: a left lower third molar (1T3N6-1980x) and a right upper canine. Based on tooth aging data from Mosby (1963: 152-53), the canine is from an animal 4 or more years old.

The molar root has been slightly shaped, and a hole bored through the root near its tip. The canine root has also been shaped so that it tapers toward the tip where remnants of several conically bored holes are visible.

Provenience. The molar came from Zone IIa; the canine has no exact provenience.

Raccoon (*Procyon lotor*)

Material. 1T3A20-1097

Discussion. An awl made from a raccoon baculum lacks the proximal end and has been worked into a point at the distal end.

Provenience. The baculum was found in Zone IIa.

Northern Fur Seal (Callorhinus ursinus)

Material.

1T1A23-159	1T1B5-615	1T1F18-2197
1T1A23-3837x	1T1B25-1127	1T2F16A-3835x
1T1A25A-3843x	1T2B16A-5296x	1T1H14A-3820x
1T2A7-3762x	1T3C16-2931x	1T1X1-3020
1T2A17-831	1T2D7-2236	1T2A23-2739x (possibly C. ursinus)
1T3A8-2748x	1T2E10-3761x	

Discussion. Sixteen teeth were complete enough for referral to C. ursinus: 6 left upper canines, 3 left lower canines, 5 right lower canines, 1 right upper third incisor, and 1 right lower postcanine. Of these, 3 canines were from males (1T2A17-831, left upper; 1T1B5-615 and 1T1X1-3020, right lower) and 11 from females; sex could not be determined from the incisor (1T1A23-3837x) or the postcanine (1T1A25A-3843x).

Using data from Scheffer (1950) and Scheffer and Kraus (1964) concerning annulations in canine tooth dentine and time of tooth root closure, estimates of age at death could be made. Of teeth from females, a left lower canine (1T1H14A-3820x) is probably from an animal between 1 and 2 years old; another left lower canine (1T2B16A-5296x) is from a seal 7 years old or more; and a left upper canine (1T3C16-2931x) is from an individual probably over 10 years old. A right lower canine from a male (1T1B5-615) is thin-walled with a short root, and probably came from an animal 1 - 2 years old. The remaining 10 canines (from both sexes) represent seals between 2 and 7 or 8 years old. The postcanine is from a seal over 2 years of age and the incisor from an animal probably 2 years old or more.

One fragmentary tooth, high polished and with most of the crown missing (1T2A23-2739x), may be the lower right canine of a female, although it cannot be definitely identified. The seal from which this tooth came would have been approximtaely 6 - 7 years old.

A minimum of 8 individuals occurs here, based on 5 female upper canines, a left lower canine (1T1H14A-3820x) from a younger female than any represented by upper canines, and 2 right lower canines from males.

The fur seal is essentially a pelagic (open-sea) animal during the months it spends away from its breeding grounds on the Pribilof Islands. Females and young animals leave the Pribilofs in October and November, dispersing down the coast where they can be found all winter, as far south as California, 10 - 50 miles offshore. Sealing records show a concentration of fur seals off Washington and Vancouver Island during March (Kenyon and Wilke 1953) before the northward migration beginning in April. Adult males are presumed to winter in the Gulf of Alaska or northward, seldom penetrating farther south. Some young, non-breeding animals can be found off Vancouver Island all summer. Fur seals rarely come inshore in the Vancouver Island region unless sick or disabled, although adult females are known to enter straits and inlets of southeastern Alaska to follow herring runs.

Recovered teeth are mainly from females and represent most age-groups; the 3 male teeth are from fairly young bulls, probably not of breeding age. This age and sex distribution seems to reflect natural occurrence of the species in the Vancouver Island region. There is no

way of telling whether these animals were hunted in the open sea or represent inshore strays or sick individuals. Drucker (1951: 46) says that fur seals were not specifically hunted until the rise of the European sealing trade in the late 19th century.

Modification. Fourteen of the 17 teeth (including 1T2A23-2739x) contained one or two conically bored holes in the root near the tip; most teeth were smoothed and polished to some degree. Only one specimen, 1T2F16A-3835x, had an articially flattened root tip; several teeth show indications of tapering towards the root tips. The Indians thus seem to have smoothed and polished fur seal teeth and bored holes in their roots so they could be strung, but not to have seriously altered the original shape in most cases.

Specimen 1T2B16A-5296x appears unmodified. A curved facet across the crown and upper part of the root as well as the blunted crown tip are the result of wear with age. A worn tooth that strongly resembles this specimen is in the Royal Ontario Museum; Scheffer and Kraus (1964: 336) illustrate a similar specimen.

Provenience. Fifteen teeth came from Zones IIa, IIIc, and IIId. One tooth came from Zone IVa, and one specimen's provenience was unknown.

Northern Sea Lion (Eumetopias jubata)

Material.

1T2A17-2734x	1T1L4A-5276x	
1T2B19-3831x	1T1A13-3785x	(probably E. jubata)
1T2F12B-2310	1T1C13A-850	(probably E. jubata)

Discussion. Three teeth can be definitely assigned to E. jubata, as follows: 1T2A17-2734x, upper right canine, female; 1T2B19-3831x and 1T2F12B-2310, postcanines, sex undetermined. Two large longitudinal fragments of canine teeth (1T1A13-3785x and 1T1C13A-850) are probably referrable to male E. jubata on the basis of size. A fragment of left radius shaft (1T1L4A-5276x) compared well in shape with a young male northern sea lion in the NMNS, but is larger; it is probably from this species.

Approximate ages of the individuals from which the teeth artifacts came can be estimated using data from Fiscus (1961) for northern sea lions and extrapolating from information on tooth growth in other pinniped species. Both 1T2A17-2734x and 1T2B19-3831x probably came from individuals under 2 years and 1T2F12B-2310 from an animal over 2 years. One of the large canine fragments (1T1A13-3785x) has a completely filled root canal, and therefore is from a mature sea lion about 10 years old or more. The other canine fragment has a partially open root canal, indicating a slightly younger individual.

At least 2 individuals are represented, a male and a female.

The northern, or Steller, sea lion ranges along the Pacific coast of North America from the Pribilof Islands to southern California. During winter sea lions are often seen along the British Columbia coast in bays and inlets and they ascend rivers to follow herring and salmon. In summer they are abundant near Vancouver Island; the Scott Islands group, just north of Vancouver Island, is one of the two largest

present-day northern sea lion rookeries, and Solander Island, just off Cape Cook, Vancouver Island, is a summer hauling-out site and former rookery (Pike and Maxwell 1958). From May to July or later there would thus be large numbers of adult and young sea lions close to Vancouver Island. Drucker (1951: 46) mentions an area off Kyuquot Sound and Clayoquot territory as places where sea lions congregated.

Modification. The young female canine had both its root edges and the crown tip flattened. One postcanine (1T2B19-3831x) had a hole bored in the root and the other postcanine (1T2F12B-2310) was notched near the root tip and possibly slightly flattened on one side of the crown. One large canine fragment had three facets along the root and the other was smoothed and shaped at the crown end to form a flattened, blunt point.

Provenience. The teeth were found in Zones IIa and IIIc, and the radius in Zone IVb.

Harbor Seal (Phoca vitulina)

Material. 1T2B17A-2842x, 1T3B25A-1167, 1T1D7-2019, 1T1J10-2356, 1T2J5B-3490x, 1T1K4B-3833x, 1T1X1-2780, 1T1X1-3242

Discussion. Eight canines from this species have been identified. Although male harbor seals are larger than females, the canine teeth of P. vitulina do not show the marked sexual difference in form that is seen among the otariids. Also, because these teeth are either from young individuals or else were modified out of their original shape by the Nootkans, they cannot be assigned with certainty to upper or lower jaw.

Four canines (1T1D7-2019, 1T2J5B-3490x, 1T1K4B-3833x, 1T1X1-3242) are thin-walled, with fairly short, widely open roots and can be characterized as "young." The remaining 4 have thick, elongate roots which are closed at the tip and are therefore "adult."

The minimum number of individuals represented is 2, but this is probably much below the true number.

Harbor seals are found close to shore more often than other pinnipeds of the Vancouver Island region. They occur in shallow coastal waters and inlets and may go quite far up large rivers. They do not form harems as do the otariids; females usually give birth hauled out on sand bars in the sea and in estuaries. Harbor seals do not migrate. According to Drucker (1951: 45), the favourite time for Nootkan harbor seal hunting was late spring.

Modification. Three "adult" canines are smoothed and polished and each has a conically bored hole in the root near the tip; the root in this area has been tapered. The fourth "adult" tooth (1T2B17A-2842x) is unmodified. Three of the 4 "young" teeth have the crown's mesial surface flattened obliquely, exposing the root canal. The fourth (1T1K4B-3833x) has a notch cut in the mesial surface of the crown and the crown tip has been flattened.

Provenience. Four teeth come from Zones IIa, IIIb, and IIIc, and two from Zones IVa and b.

Northern Elephant Seal (Mirounga angustirostris ?)

Material. 1T2K11A-3758x

Discussion. One longitudinal tooth fragment from a large sea mammal may be the canine of an elephant seal. This flattish section of root and lower crown was compared with a canine from the southern elephant seal at the Royal Ontario Museum and found to be similar. Cetacean reference material is rare, but the specimen did not resemble any cetacean teeth seen. This identification should be considered tentative.

One individual is represented.

The northern elephant seal's normal range is from Mexico north to California, but a few records exist for British Columbia. This is the largest pinniped found along the British Columbia coast.

Modification. The specimen is a thin, longitudinally split piece. The split edges are slightly smoothed and the crown end has been broken or chipped into a rough point.

Provenience. The fragment was found in Zone IIa.

Other Sea Mammal Artifacts

Material.

1T3A5-3850x	1T2G16-3815x	1T1N3-3787x
1T1B7-654	1T2J9-2057	1T1X1-3018
1T2B23-2847x	1T1K7-1524	1T1X1-3088
1T2G7A-1446	1T1K14A-3508x	

Discussion. Five teeth and 6 bones were not specifically identifiable, but could be assigned to various sea mammal categories with some degree of certainty.

A postcanine (1T2J9-2057) with much of the crown and neck missing must have come from either a California or a northern sea lion. The root of this tooth has been tapered toward the tip on four sides. A longitudinal fragment of canine root and crown (1T1B7-654) is from a member of the family Otarridae, and could have come from either a northern fur seal or one of the sea lions. This fragment is polished and bears a conically bored hole in the root. A longitudinal section from a large canine tooth (1T1K7-1524) is from a large pinniped, probably a northern sea lion. This section through crown and root is approximately 6 mm thick and well polished. A tooth root fragment with 2 holes bored near the root tip (1T3A5-3850x) is probably an upper canine or upper third incisor of a large pinniped.

A large tooth, probably a large sea mammal canine (1T2G7A-1446) has been worked into the shape of a seal. A small bit of enamel is visible at the figure's head. This carving probably represents a hair seal because the hind legs are portrayed as pointing backwards. Hind

flippers of phocid seals are directed rearwards, in contrast to those of otariids which turn forward and are more suitable for land locomotion.

Four small bones (1T2B23-2847x, 1T1K14A-3508x, 1T1N3-3787x, 1T1X1-3018) are phalanges from otariid seals, and a fifth bone fragment (1T2G16-3815x) may possibly be part of a similar toe bone. All 5 of these artifacts have conically bored holes in one end.

A portion of fibula shaft (1T1X1-3088) with one end shaped into a long conical point is also from a pinniped, probably a fur seal or California sea lion. The artifact has been classified as a fine-pointed awl.

Provenience. Two teeth are from Zones IIa and IIIb, and 3 from Zones IVa and b. Four of the 5 seal phalanges came from Zone IIa; 1T1X1-3018 had no definite provenience. The fibula also had no provenience.

Cervidae, Species Undetermined

Material. 1T3A27A-1587

Discussion. One antler tine fragment was assigned to the family Cervidae. The two members of this family occurring on Vancouver Island are the black-tailed deer, Odocoileus hemionus, and the elk, Cervus canadensis. This fragment is probably from a deer, but since antler reference material was temporarily unavailable at the time this study was made, the artifact was not assigned to species.

Modification. The tine is unevently broken proximally. The tip (distal) has been smoothed to a slightly convex surface and forms a blunt point.

Provenience. The specimen came from Zone IIa.

Black-Tailed Deer (Odocoileus hemionus)

Material.

1T1A27-1585x	1T3C17A-2933x	1T1G18-2369	1T2J17B-2760
1T3A8-2747x	1T3C19A-2936x	1T2G5-3393x	1T1K14B-3509x
1T3A23-2807x	1T1D15B-2591	1T2G10-3401x	1T2K4A-3512x
1T1B13-2817x	1T1D17A-2950x	1T2G16-3402x	1T2K4B-3513x
1T1B15B-2826x	1T1E8-2968x	1T2H11-2325	1T2K11A-2554
1T2B6-2834x	1T1E10-2970x	1T2H18A-2412x	1T1L4A-1756
1T3B23A-1128	1T1E12-2973x	1T1J12-2388	1T1L9A-2544
1T3B26B-1190	1T2E8-2989x	1T1J13-3465x	1T1A-2662
1T1C15B-2878x	1T2E12-2999x	1T1J13-3466x	1T1X1-3077
1T1C24-1556	1T2E14A-3333x	1T1J14-2428	1T1X1-3109
1T2C12-2900x	1T2E14A-3806	1T1J14-3794x	1T1X1-3114
1T2C21A-1145	1T1F17-2141	1T2J15-2194	1T1X1-3123
1T2C22-1154	1T2F12C-3369x	1T2J16-2696	1T1X1-3132
1T3C13B-3801x	1T2F21-2300	1T2J16B-3757x	1T1X1-3201
			1T1X1-3243

Discussion. Fifty-seven of 66 identifiable pieces of bone in this collection belonged to deer. The fragments were assignable to skeletal element as follows: ulna, 42; metatarsal 3 + 4 (hind cannon bone), 8; metacarpal 3 + 4 (front cannon bone), 2; astragalus, 2; innominate, 1; radius, 1; metacarpal 2 or 5 (splint bone), 1.

Eighteen left and 22 right ulnas could be identified; 2 ulna shaft fragments could not be assigned to either right or left sides. Degree of proximal epiphyseal fusion could be seen of 14 right and 9 left ulnas; 5 right and 1 left epiphyses were fused to their diaphyses; 9 right and 8 left had lost their epiphyses and were classed as unfused. Lewall and McTaggart Cowan's study (1963) on pen-reared black-tailed deer indicated that the proximal epiphysis of the ulna began to fuse to its diaphysis at approximately 2½ years of age, and active growth in the epiphysis ceased when an animal was about 3 years old. Malnutrition retarded epiphyseal fusion. Most of the deer used in that study were O. hemionus columbianus, the subspecies occurring on Vancouver Island and the adjacent mainland. Thus many of the deer from which these ulna artifacts came were young, probably less than 3 years old.

The second most numerous deer artifacts were the metatarsal 3 + 4 and metacarpal 3 + 4; these long, tubular bones, especially the metatarsal, were favourite materials for the manufacture of bone tools among many Indian groups.

A minimum number of individuals was calculated for the most numerous element, the right ulna. There were 16 proximal ulna portions and 6 mid-shaft fragments. Two proximal portions are short enough that a mid-shaft portion could have come from the same bone; 4 mid-shaft fragments could not have come from the same bone as any of the proximal ends. Therefore the maximum number of individuals represented is 20.

The coast deer, O. h. columbianus, occupying Vancouver Island, is a small form of black-tailed deer. These animals are good swimmers and are found on some of the offshore islands as well as on Vancouver Island. Drucker (1951: 9, 38) reports that the coastal Nootkan groups depended very little on forest game resources, but that they did take deer during the winter.

Modification. Most of the ulnas were shaped into various awls. The radial articulations were sometimes cut away or at least an attempt had been made to remove them; presumably they interferred with the tool's proper "fit" in the hand. Faint cut marks on the olecranon's medial side in 2 specimens (1T1L4-1756, 1T1X1-3077) or on the lateral side (1T2G16-3402x) may be butchering marks incurred during forelimb disarticulation.

The metacarpal, metatarsal, innominate, and radius fragments were also made into awls. One of the 2 astragalus artifacts (1T1J14-3794x) was only slightly modified, with a groove cut across the dorsal side, another on the plantar side, and a hole bored in one end. The other (1T1A27-1585x) had been cut away on dorsal and plantar sides to form an object with a sort of double hook at one end. There was a hole bored partway through the opposite end.

Provenience. Deer artifacts were found in Zones I - IV, although only one specimen (1T3B26B-1190) came from the uppermost level of Zone Ib. Most bones were found in Zones IIa, b and IIIc.

Unidentifiable Mammal Teeth

Material.

1T1A12-429x	1T2C9-607	1T2G15-2064
1T3A11-326	1T2G9-1517	1T1K12-3506x
1T3B10-648x	1T2G9-3829x	1T1X1-3265

Discussion. Nine tooth artifacts can be identified as having come from medium to large mammals, but more exact identification is impossible since the pieces have been highly modified or are only fragments. Most probably are of pinniped origin. Six artifacts contain bored holes; two (1T3A11-326, 1T2C9-607) are shaped into elongate curved objects, and one (1T1A12-429x) is a fragment of crown flattened on the inner face.

Provenience. These artifacts came from Zones IIa, b and IIIb, c, except for 1T1X1-3265 for which provenience is unknown.

Unidentifiable Bone Awls

These are listed by type and zoological class.

Grooved awls (whole)

Land mammal

1T1C32-2692	1T2E20-2093	1T1H10-1540x
1T3A6-2742x	1T2F21-2370	1T1H192-3836x
1T2E11-3825x	1T2G5-3392x	1T3N7A-3544x
		1T1X1-3158

Bird

1T2J4A-3478x (right humerus, large bird)

Class uncertain

1T1A25A-1576

Grooved awls (splinter)

Land mammal

1T1A19-875	1T1B20-823	1T1E29B-2647	1T2K15-3518x
1T1A22-1551	1T2C19A-2912x	1T2F30B-2520	1T1L11B-2541
1T1A24-1571	1T3C26-1080	1T1H18A-2154	1T1L12B-2576
1T2A22-1170x	1T3C26-2940x	1T2H18-2383	1T1X1-2402x
1T3A8-2853x	1T3C27-1092	1T1J9-2354	1T1X1-3010
1T1B17-794	1T1D8-2046x	1T2J16-2751	1T1X1-3082

Fine-pointed awls

Land mammal

1T3A6-2741x	1T1J19A-2574
1T1D16a-2594	1T1L14B-2602
1T1F7-1260	1T1L14C-2643

Bird

1T2A22-1159	1T1L23B-2572

Broad-pointed awls
  Land mammal
    1T1A6B-322 1T3B23A-1131 1T2C20A-1134 1T1J15-2437
    1T1A24-1565 1T1C33-2638 1T2F13A-2317 1T2J13-2165
    1T3A10-321 1T2C13-758x 1T2F28B-2483 1T1M11A-2196
    1T3A19-929 1T2C20A-1130 1T1G17B-2273 1T1X1-735
                                          1T1X2-3040

Miscellaneous awls
  Land mammal
    1T3A16A-892
  Bird
    1T1A10-2716x 1T1F5-1243
    1T1A15B-284 1T2F8A-3738x
    1T1X1-3085 (left carpometacarpus, large bird)

References Cited

Dewhirst, John. 1980. The Indigenous Archaeology of Yuquot, a Nootkan Outside Village. National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, No. 39, The Yuquot Project, Vol. 1.)

Drucker, Philip. 1951. The Northern and Central Nootkan Tribes. Bureau of American Ethnology Bulletin 144, Smithsonian Institution, Washington.

Fiscus, Clifford H. 1961. Growth in the Steller Sea Lion. Journal of Mammalogy, Vol. 42, No. 2, pp. 218-33.

Kenyon, Karl W. and Ford Wilke. 1953. Migration of the Northern Fur Seal, Callorhinus ursinus. Journal of Mammalogy, Vol. 34, No. 1, pp. 86-98.

Lewall, E.F. and I. McTaggart Cowan. 1963. Age Determination in Blacktail Deer by Degree of Ossification of the Epiphyseal Plate in the Long Bones. Canadian Journal of Zoology, Vol. 41, No. 4, pp. 629-36.

Mosby, Henry S. (ed.) 1963. Wildlife Investigational Techniques. The Wildlife Society, Washington, D.C., Second Edition, Revised.

Pike, Gordon C. and Brian E. Maxwell. 1958. The Abundance and Distribution of the Northern Sea Lion (Eumetopias jubata) on the Coast of British Columbia. Journal of the Fisheries Research Board of Canada, Vol. 15, pp. 5-17.

Rick, Anne B. 1973. Identification and Description of Selected Artifacts from Yuquot, British Columbia. Manuscript Report Series No. 159, pp. 133-60, Parks Canada, Ottawa.

Scheffer, Victor B. 1950. Growth Layers on the Teeth of Pinnipedia as an Indication of Age. Science, Vol. 112, pp. 309-11.

Scheffer, Victor B. and Bertram S. Kraus. 1964. Dentition of the Northern Fur Seal. Fishery Bulletin of the Fish and Wildlife Service, Vol. 63, pp. 293-342. U.S. Department of the Interior, Washington.

Zooarchaeological Analysis of Mollusc Remains from Yuquot, British Columbia

Louise R. Clarke and Arthur H. Clarke

38 Abstract
39 Acknowledgements
40 Introduction
41 Materials and Methods
42 Results
49 Discussion and Conclusions
49 Faunal Changes
50 Seasonality
52 Food Value
55 Summary
56 References Cited

Abstract

In this paper the authors present an analysis of shellfish remains sampled archaeologically from the Nootkan Indian village of Yuquot, Nootka Sound, British Columbia. The shellfish remains, which cover the period 2300 B.C. - A.D. 1966, include 39 species of marine molluscs, three species of terrestrial molluscs, and some non-molluscan invertebrates. A significant shift from dominance by epifauna (Mytilus californianus, Nucella lemellosa, etc.) to dominance by infauna (Tresus nuttalli, Saxidomus gigantea, Protothaca staminea, etc.) occurs at the transition from prehistoric to historic periods of occupancy. This is believed to have resulted from ecological restructuring caused by near extinction of the sea otter early in the historic period. Examination of the shells also shows that molluscs were gathered throughout the year since A.D. 800 and suggests summer harvesting from 1000 B.C. to A.D. 800. Complete results of the analysis are presented in tables and histograms.

Submitted for publication 1974, by Arthur H. Clarke, National Museum of Natural History, Smithsonian Institution, Washington.

Acknowledgements

We are grateful to several colleagues for assistance. Special thanks are due to Mr. J.T. Dewhirst for archaeological advice and editorial counselling, to Mr. R.S. Palm for untiring and reliable periodic live specimen collecting throughout 1971, to Mrs. M.F.I. Smith and Ms. Jane Topping for able laboratory assistance, and to the late Dr. D.G.S. Wright for expert field assistance in 1973. Valuable technical assistance and advice was also received from F.R. Bernard, W.J. Folan, F.W. Grimm, D.B. Quayle, Anne M. Rick, and A.E. Wilson. The art work was done by C.H. Douglas and the drafting of graphs by S. Epps. Appreciation is also expressed to the Department of the Environment for financial and technical support, and to the National Museum of Natural Sciences for technical and stenographic assistance.

Introduction

Numerous studies have shown that culture-related mollusc shells may assist in clarifying the ethnohistory of native peoples. The systematic excavations at Yuquot (Folan 1969; Folan and Dewhirst 1970; Dewhirst 1980), a site that spans more than 4000 years of occupation, yielded large quantities of faunal material. It was with great anticipation and interest that L.R.C., early in 1968, began the task of segregating the mammal bones, bird bones, fish bones, and invertebrate shells and then sorting, identifying, counting, and weighing the voluminous shell remains from this important archaeological site.

Many questions and problems came to mind during the course of the work which, it was hoped, might be elucidated by careful investigation of this material. What was the role of molluscs as a Nootkan food resource? During what seasons were molluscs gathered and how were they prepared as food? Are there changes in the faunal compositon of these deposits through time and, if so, what do these changes mean? Do they reflect faunal migrations, changes in climate, changes in food preferences or availability, or occupation of the site by different peoples during successive temporal intervals?

In the following pages the methods employed and the results obtained will be discussed. This is in large part, however, a data report. Interpretations have been attempted where they appear to be warranted, and a full tabulation of the data is on file at the Archaeological Research Section, National Historic Parks and Sites Branch, Parks Canada, Ottawa. Such data may well provide bases for additional interpretations and for comparisons with the materials from other archaeological excavations along the northwest coast of North America.

Materials and Methods

The faunal remains from Yuquot consisted of 96 ft.^{3} of mixed bone and shell material subdivided and labelled to correspond with the hundreds of 5-ft.^{2} and 6-in. deep sample units of the excavation (Dewhirst 1980). The faunal material was first sorted into three categories: mammal and bird bones, fish bones, and shellfish (mollusc shells, barnacle shells, and sea urchin tests). Mammal and bird bones made up 50% of the material, fish bones 15%, and shellfish (almost entirely mollusc shells) 35%. Approximately 520 of the samples that were sorted contained shellfish. Many faunal collections from the lowest levels of the site were so cemented by partial dissolution and subsequent precipitation, however, that sorting was impossible.

Next, the shellfish collection lots were sorted to species lots, where possible, and within each species lot the following sub-lots were segregated: 1) gastropods: complete specimens, partial specimens (more than half complete), other fragments; 2) bivalves: complete left halves, complete right halves, hinge fragments of left valves (more than half the hinge present), hinge fragments of right valves, other fragments; chitons: plates; 3) barnacles: plates, and small shell fragments that could not be identified. The specimens in each segregated sub-lot were counted, weighed, and tabulated. These sub-lots were then put back together in small bags to reconstitute the species lots and all the material was then stored for further examination, should this be necessary.

Collections of living molluscs were made at the beginning and middle of each month throughout 1971 to provide a basis for recognizing from growth lines what seasons of the year the archaeologically recovered molluscs had been gathered and for estimating the amount of edible food they represented. The specimens were collected at Opitsat, near Tofino, Vancouver Island. Tofino was the closest permanent settlement to Yuquot where year-round assistance could be obtained. One hundred and twenty-one lots totalling more than 3000 living specimens were gathered, with emphasis on the species dominant in the archaeological material.

Finally, to facilitate further interpretation of the faunal remains, on July 13 and 14, 1973 A.H.C. visited Yuquot. Numerous photographs were taken and collections of living molluscs were made at the village and in the vicinity by the use of SCUBA diving gear.

Results

The species of marine molluscs found in the midden are listed, with ecological setting and stratigraphic distribution, in Table 1. Five species of intertidal molluscs predominate: the epifaunal or rock-dwelling California mussel, Mytilus californianus, and the fringed dogwinkle, Nucella lamellosa; the infaunal or sand-dwelling native littleneck clam, Protothaca staminea, the butter clam, Saxidomus gigantea, and the horse clam, Tresus nuttalli. Chiton and barnacle plates were much less abundant, but nonetheless widespread in the midden.

The dominant bivalve and gastropod species, and several other species that occurred less frequently in the midden, are illustrated in Fig. 1-3.

After the initial detailed analyses were completed, it became apparent that consistent shifts in the relative proportion of certain species occurred with decreasing depth in the midden. In the lower levels, epifaunal species such as M. californianus, N. lamellosa, and Astraea gibberosa et al. were dominant, but decreased in importance in later deposits and were of secondary importance in the most recent levels. By contrast, in the uppermost layers the infaunal clams P. staminea, S. gigantea, T. nuttalli, and Clinocardium nuttalli et al. were dominant, but in the lower levels they were uncommon or absent. In the lowest levels cemented bone and shell material predominated.

The matrix of the cemented material was harder and more durable than the shells and bones it contained. Since it could not be selectively dissolved, softened, or fragmented, no reliable estimate of its relative composition could be made. A substantial quantity of uncemented material was also present in these levels. The "shellfish" component of the cemented material is believed to be similar to the species composition of this uncemented material.

The faunal changes correlate well with four major stratigraphic zones based on midden matrix, artifact types, and radiocarbon dating (Dewhirst 1980):

Zone IV: A.D. 1790-1966
Zone III: A.D. 800-1790
Zone II: 1000 B.C.-A.D. 800 (bulk of deposition after 200 B.C.)
Zone I: pre-2300-1000 B.C.

The Zone III-Zone IV interface is closely concordant with the shift in dominance from epifauna (species living on or attached to rocks) to infauna (species living in gravel, sand, or mud). In Zone III, the ratio of infauna to epifauna is 0.15: 1, but in Zone IV it increases to about 4.2: 1 (Fig. 4). Table 1 is therefore arranged to distinguish between epifauna and infauna by stratigraphic zone.

To reduce the data to a conceptually more manageable format, weight subtotals for the dominant species and species groups were calculated for each zone, and the results were also presented graphically (Fig. 4). Conventional linear histograms were undesirable, because the

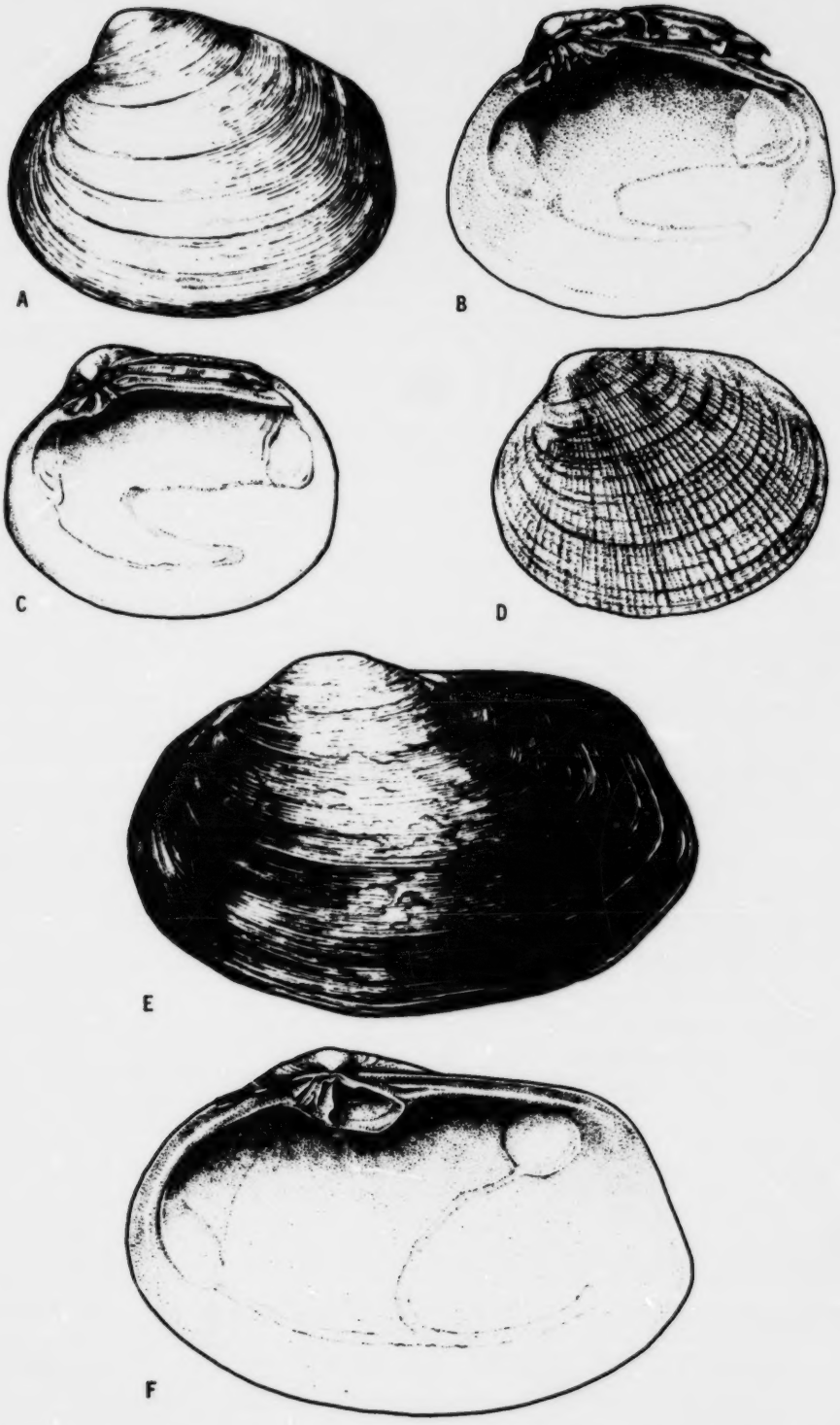


Fig. 1. Marine bivalves. A, B, Saxidomus giganteus (X0.8); C, D, Protothaca staminea (X0.8); E, F, Tresus nuttalli (X0.8).

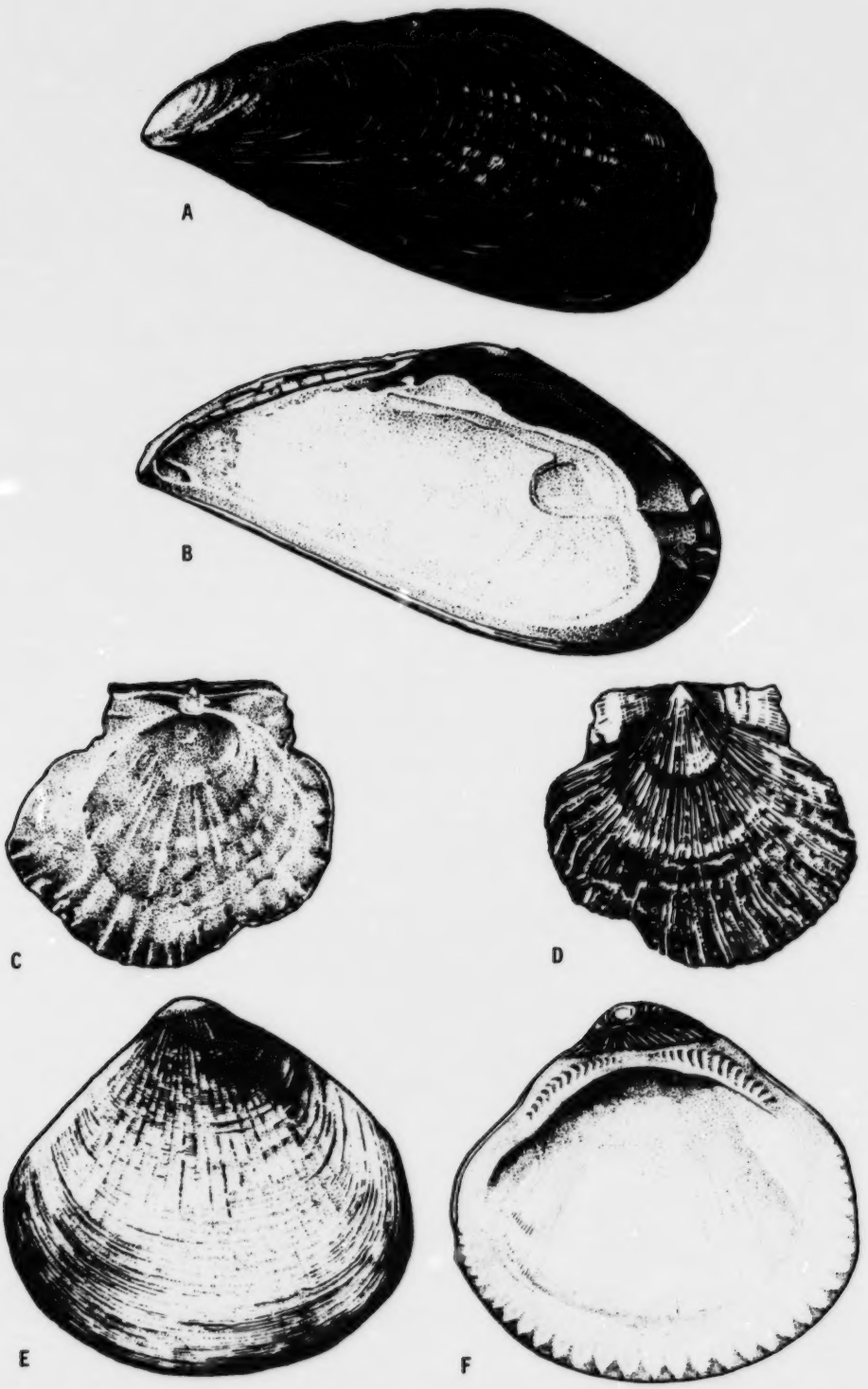


Fig. 2. Marine bivalves. A, B, Mytilus californianus (X0.8); C, D, Hinnites multirugosus (X0.4); E, F, Glycymeris subobsoleta (X2.4).

Fig. 3. Marine gastropods. A, Nucella lamellosa (X1.6); B, N. canaliculata (X3.2); C, Natica clausa (X1.6); D, Polinices lewisi (X0.8); E, Crepidula adunca (X1.6); F, Astraea gibberosa (X0.8); G, Tegula brunnea (X1.6).

relationships between very small quantities were obscured when very large quantities were represented on the same graph. Logarithmic and power functions were also considered, but were judged to be misleading. Therefore two-dimensional histograms were used in which bar area (rather than bar length) is proportional to the total shell weight of the pertinent species or species groups.

Some shell artifacts were found and should be mentioned here for completeness. Four artifacts of M. californianus were a pendant (1T1G17B-3574x), a fragment of a knife or sharpened spoon (1T2D15B-5295x), and two celts (1T1H15-1336, 1T1J13-2424). One pendant (1T1J13-2421) of Ostreidae and a piece of worked shell of unidentified species were also found. The two scaphopod fragments (Dentalium sp.) which occurred in Zone IV probably had exchange or trade significance. These finds are discussed by Dewhirst (1980).

Other finds of interest are fragments of an unidentified sea urchin test in sample 1J22, and specimens of the carnivorous soil-burrowing terrestrial snails Haplotrema vancouverense (Lea) and H. sportella (Gould), and the phytophagous terrestrial snail Vespericola columbiana (Lea) throughout Zones III and IV. The land snails are no doubt adventitious and were not used as food.

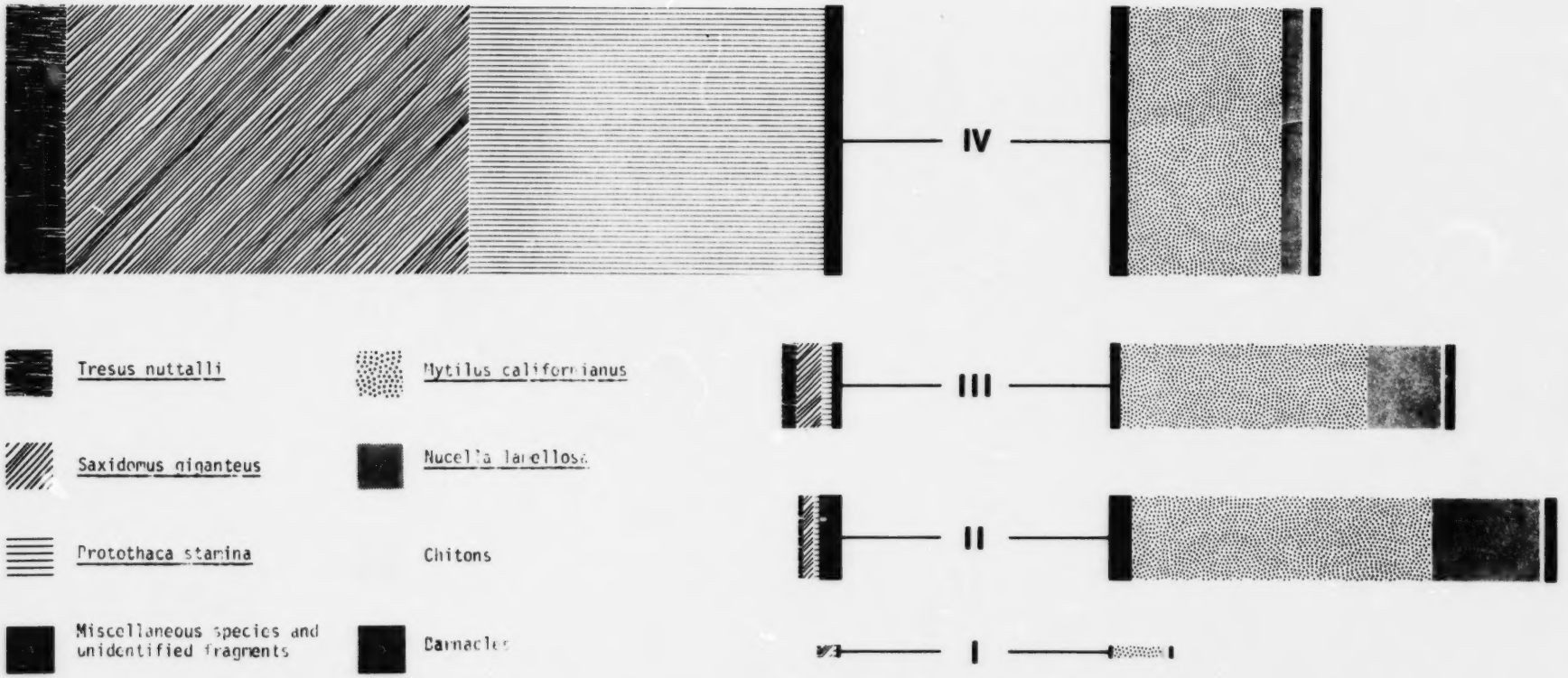


Fig. 4. Relative abundance by shell weights of infaunal and epifaunal species collected from each stratigraphic zone. Bar areas are proportional to shell weights. See Table 3.

Table 1. Yuquot Mollusc Species, Ecology, and Distribution by Stratigraphic Zone, Grid Square, and Level

Species	Ecology Substratum	Depth	Excavation Grid Squares and Levels (Dewhirst 1980: fig. 14-17) Zone I	Zone II	Zone III	Zone IV
Chitons						
Cryptochiton stelleri (Midd.)	Rock	Intertidal to 5 m			1F8	1G4; 1H6; 2C2,3; 2G7; 2H4.
Katharina tunicata (Wood)	Rock	Intertidal	3C29	3C19	2K6; 3C17	1B2,3; 1C1,2,4; 1D2,3,5,6,7,8; 1E2,5; 1F2; 1G2,3,4,5,7,8; 1H4,6; 1L2; 1M1; 2A1,2; 2B2,3; 2C1,2,3; 2D1,4; 2E1; 2F3,4,5,6A; 2G1,2,3,4,7,8; 2H1,5; 2J2; 3A1,2; 3A1,2; 3B1,3,4; 3C1,2,3
Scaphopods						
Dentalium sp.	Sand, mud	?				1F4
Gastropods						
Acmaea mitra Rathke	Rocks	Intertidal				1B1; 1C1,2; 1D2,3;
		to 20 m				1H3; 2C1,2,3; 2D1; 2F5A; 2G3,8; 2H3; 2J2
Notoacmaea scutum (Rathke)	Rocks	Intertidal				2K2
Collisella digitalis (Rathke)	Rocks	Intertidal				2C2; 2D1
Diodora aspera (Rathke)	Rocks	Intertidal				1B2; 1L1; 2C3
Tegula funebralis (A. Adams)	Rocks	Intertidal		1L13; 3B1B	1F8	1A1,2,3; 1B1,2,3; 1C2,3; 1E1,2; 1F3,5; 1G3,4,5,8,7,9B; 1H3; 2A1; 2B2; 2C1,2; 2D1,2; 2E3,4; 2F8; 2G2,3,6; 2J2; 3B1,3; 3C1,2,3,4,7
T. Pulligo (Gmelin)	Rocks	Intertidal to 10 m			1G8A,12	1G9B; 1F4; 1H4; 1L1; 2B1; 2F1; 2G2,3; 3C4
Calliostoma ligatum (Gould)	Rocks	Intertidal to 250 m				1C2; 2C3; 2D1,2; 3C2
Astraea gibberosa (Dillwyn)	Rocks	Intertidal to 20 m		1N2,4,5,6; 1A22; 1N11, 12; 1K12,14; 1L11,13,14; 1N11,12,13, 14; 2N1,2,3, 4,5,6; 2D18; 2N13; 2J11,12; 2K10,11,13,14, 15, 2L10,12,13, 3C13 14,15; 2M11, 12,13,14; 3N3,4,5	1A5B,7B,12; 1B14; 1C1D, 14; 1D12,16; 1E7; 1F8,11; 2A12; 2B12; 2C15,17; 2D14,16,17; 2E7,8,13; 2C9; 3A11;	1A1,2; 1B1,3; 1C1,2,3; 1E1,2,4; 1F3,5,7B; 1G4,5,6,9B; 1H6; 1J4; 2A1; 2B1,3, 2C1,4; 2D1,2,4; 2E1; 2F3,5; 2G2,4,5,8A; 2H4,5; 2J2; 3A2; 3B1,2,3; 3C2, 3
Littorina sitkana Philippi	Rocks	Intertidal		1L13	2C16	2J1
Crepidula adunca Sowerby	Shells	Intertidal to 20 m				1C3; 2G8B; 3C3
C. nummaria Gould	Rocks, shells	Intertidal to 5 m		3N4		2D1,2
Crepipatella lingulata (Gould)	Rocks, shells	Intertidal to 40 m				3B1; 3C2
Natica clausa Brod. & Sby.	Sand, mud	Intertidal to 200 m		1L14; 1M10, 12; 2B22; 2J18; 2K9; 3S2	2H6D	1C1; 1J2; 1K2; 1L1; 1N2; 2B2; 2E3; 2H2,4,5; 2J1
Polinices lewisi (Gould)	Sand	Intertidal to 50 m		1J15; 2B4; 3N4; 3C23	1A14; 1B14; 1D6; 2A12; 2C13	1N3; 1D6; 1L2,3B; 2B4
Ceratostoma foliatum (Gmelin)	Rocks	Intertidal to 50 m				2C1
Nucella canaliculata (Duclos)	Rocks	Intertidal		1N2,5,6; 1A20,22; 2N3, 4,5; 2A20; 2G15; 2K14; 2L13; 3A10A, 23	1A16,17B; 1B15; 1C14, 15,16; 1D16; 1F8; 2A13, 14B; 2B15; 2C16,17; 2D15,16; 2E7B,8; 3C17	1D4; 1C1,2,3,4; 1D2,3; 1E2; 1G5; 1N3; 1J4; 1K4; 1N2; 2B2; 2C1,2,3,5; 2D2; 2E1; 2F5; 2G3,6,7B; 2H2,3,4; 2J2,4; 3B1; 3C2,3,4
N. emarginata (Deshayes)	Rocks	Intertidal			2A14B	1C2,3; 2C2, 2F3
N. lamellosa (Gmelin)	Rocks	Intertidal to 15 m		Widespread		
N. lima (Gmelin)	Rocks	Intertidal			2A14A	1C2; 2A2; 2C1,2; 1D1; 3C2,7
Searlesia dira (Reeve)	Rocks	Intertidal		2C21; 2F20; 3C21	2G7B,8B; 3C17	2F6A, 2J2; 2L2; 3B1; 3C2
Olivella boetica (Marrat)	Sand	Intertidal to 30 m			1G7B	1A1,2; 1G2
Muniopsis incisa (Carp.)	Mud	15 - 30		1C20		2F3
Oenopota reticulata (Brown)	Mud	10 - 1450				2C3
Bivalves						
Clycymeris subobsoleta (Carp.)	Sand, gravel	Intertidal to 80 m				1A2; 1G2,4; 1E5; 2C1; 2D1,3; 2F5A; 2G7B; 2K3
Mytilus californianus Conrad	Rocks	Intertidal to 30 m		Widespread		
Hinnites multirugosus (Gray)	Rocks	Intertidal to 30 m		1N2; 1J12; 2A18,19,22; 2J12; 2K13,15	1B9	1B1, 1C1,2; 1D5,8; 1H3; 1J4; 1L2; 2B1; 2F6A; 2G3; 2L2,3; 3B1; 3C2,4
Pododesmus macroschisma (Desh.)	Rocks	Intertidal to 20 m		2B2		1D2; 2B1; 3C2
Crassostrea gigas (Thunberg)	Rocks	Intertidal				surface; 1M1
Pseudochama exogyra (Conrad)	Rocks	Intertidal to 20 m			1A17B	
Clinocardium nuttalli (Conrad)	Sand, mud	Intertidal to 10 m			2F7B	1B1,2; 1C2,3,4; 1D2,3; 1E2; 1F4; 1G5; 1H6A; 2B1; 2C1,2,3; 2D1; 2F3; 2G1,5; 2H2; 2J1; 2K2; 3A1; 3B1; 3C2,3,4
Spisula falcata (Gould)	Sand	Intertidal to 5 m				2C2; 2D2; 3C3
Tresus nuttalli (Gould)	Sand, mud	Intertidal		Widespread		
Saxidomus giganteus Deshayes	Sand, gravel	Intertidal to 20 m		Widespread		
Protothaca staminea (Conrad)	Sand, gravel	Intertidal		Widespread		
Humilaria kennerleyi (Reeve)	Sand, gravel	Intertidal to 50 m				1A2; 1D3
Panopea generosa (Gould)	Sand, mud	Intertidal to 20 m				3C2

Discussion and Conclusions

Faunal Changes

Thick-shelled and thin-shelled species occur throughout the site so the faunal changes that are observed are considered to be real, i.e. not the result of differential preservation. The question is, Are the faunal shifts likely to be attributable to natural phenomena, to the activities of man, or some combination of both? Natural phenomena include natural faunal changes perhaps mediated by climatic shifts. Pertinent activities of man include advances in technology, changes in food preferences, overharvesting of certain species, or ecological disruption.

All of the mollusc species found in the site are found alive in British Columbia at the present time (Keen 1937; Abbott 1954; Bernard 1970; Rice 1972). Since no species now confined to more northern or more southern latitudes are present there is no evidence, on that score, that profound climatic changes have occurred. The climate during the deposition of Zone III might have been slightly warmer than that during Zone II or Zone IV (Clarke and Clarke 1975), but even if important climatic change had occurred it would not account for the shift from epifaunal to infaunal dominance at the Zone III - Zone IV interface. Epifaunal and infaunal species occur in all mollusc faunas, and climatic changes that would produce species replacements in one group would affect the other group as well.

Since climatic changes cannot account for the faunal shift, it is useful at this point to consider the historical record. The base of Zone IV marks the beginning of sustained Caucasian contact with the Nootka people (Dewhirst 1980). It is tempting to speculate that the Spanish soldiers who occupied Yuquot from 1789 to 1795 taught the Indians to eat more clams and other marine molluscs. Of course this is possible, but clams occur in earlier levels of the site also, albeit in considerably reduced numbers, so the Nootkans must have already been aware of their value.

Another event, concordant with and related to the onset of sustained contact, may have been of much greater biological significance (previously reported by Clarke and Clarke 1975 in which present Zone I was Zone IV, Zone II was Zone III, Zone III was Zone II, and Zone IV was Zone I). This was the exploitation and subsequent local extinction of the sea otter (Enhydra lutris L.). Sea otters had been abundant in the region until about 1790, after which they became rare and were soon extirpated (Moziño 1970). Sea otters feed almost exclusively on mussels, clams, sea urchins, and fish (Kenyon 1969). An average adult sea otter, in fact, requires about 11 lbs. (5 kg) of food each day (Estes and Palmisano 1974).

At the present time epifaunal molluscs are abundant on rocks at Yuquot and in the surrounding area. Bottom-dwelling clams also occur at Yuquot but they are not abundant there. Dense clam beds occur across

the Inlet near Broughton Island, however, and presumably elsewhere in the area.

Therefore the Indians probably harvested many mussels and other epifauna from rocks near the village but obtained clams from some distance away. Sea otters no doubt avoided the village and its environs so the local supply of epifauna would not have been seriously affected. The otters would probably have had a significant limiting effect on the more distant clam beds, however, and likely the development of dense clam beds in the region may not have been possible while sea otter abundance remained great. (See Simenstad et al. 1978 for an important interpretive analysis of an Aleut archaeological site in which a similar shift in invertebrate utilization was convincingly attributed to local sea otter extinction.) Infaunal molluscs therefore probably become much more numerous subsequent to 1790 and this may well be the reason for their greatly increased abundance in Zone IV.

The sudden increase in Zone IV of several small intertidal snails (Tegula funebralis, T. pulligo, Acmaea mitra, and Searlesia dira) may reflect a period of privation. These snails are so small that they would likely have been eaten only at times of near starvation.

Some very small subtidal species, for example Monilopsis incisa and Oenopota reticulata, are no doubt accidentally in the midden. They are deep-water species, and were probably within the digestive tracts of fishes caught for food.

In general, there are few striking differences between Zone II and Zone III. The ratios of epifauna to infauna, and various species to one another (Fig. 4) suggest that the pattern of utilization of mollusc resources remained fairly constant for the time period represented by those zones.

The red turban snail, Astreae gibberosa, a large and conspicuous rock-dweller, is more abundant in Zone II than in Zone III. The reduced quantities in Zone III may have resulted from scarcity created by overharvesting, similar to the way in which overharvesting of its ecological equivalent the West Indian top shell, Cittarium pica (L.), in the Caribbean has produced local scarcity. Finally, there are several occurrences of the arctic moon snail, Natica clausa in Zone II and in Zone IV, but none in Zone III. Natica clausa is known to occur in fish stomachs. The deposits of Zone II and Zone IV were associated with household and residential activities (Dewhirst 1980); the absence of N. clausa in Zone III may reflect non-household or non-residential activities for those deposits and area of the site.

Zone I is similar to Zones II and III, but it contains much less faunal material and predominantly fragmented valves. These fragments do not indicate whether or not the "left-right valve effect" occurred. (Wave action sometimes sorts valves on a beach into groups of left valves and right valves). The bivalve remains of Zone I therefore provide little information regarding whether or not the midden at that stage of development was exposed to storm waves, as has been suggested (Dewhirst 1980).

Seasonality

Drucker (1951, 1963) has reported that during the first third of this century the Nootka people gathered molluscs chiefly during the

winter when other game was scarce and stockpiled food was running low. Molluscs were also gathered at other times of the year, however. Whether or not this custom prevailed with earlier inhabitants of Yuquot is unknown.

At the beginning of this study, it was assumed that the archaeological shells would clearly reveal the seasons during which they were gathered, by the positions of the outermost edges with respect to the previous annual growth rest. For background information see Fraser and Smith (1928a, b). The specimens of Protothaca, Saxidomus, Tresus, and Mytilus collected alive at regular intervals throughout 1971 were carefully examined for growth characteristics and compared with archaeological material. It was soon discovered that interpretation of seasons by this method was fraught with uncertainties. In the first place, it was not always possible to distinguish annual growth rests from disturbance rings in live-collected material using unaided vision, a microscope, or even X-rays. The archaeological material was invariably worn, and growth rests were even less distinct than in recently collected, unworn material. Secondly, although as a living clam becomes older the distance between each new annual growth ring and the last previous ring becomes less and less, the progression is irregular. Thirdly, although small specimens exhibit annuli that are far apart, in large specimens the later annuli are very close together. The archaeological material contains relatively few small specimens, and few that could be seasonally interpreted with any substantial degree of confidence.

Since the uncertainties were so severe and the expenditure of time so great to attempt a seasonal interpretation of all the material, it was decided to examine only subsamples. The results of this examination are given in Table 2.

Table 2. Season of Capture Estimates for Yuquot Molluscs

Zone	Grid/Level	No. of Specimens Winter - Early Spring	No. of Specimens Late Spring - Fall	Species
IV	1A1	10	4	S. giganteus
	1A2	2	10	" "
	1A3	0	2	" "
	1A5	1	1	" "
	1B3	15	14	" "
	1C7	0	2	P. staminea
	1G8	0	4	S. giganteus
III	1A9	1	0	S. giganteus
	1A16	0	1	" "
	1C9	0	2	" "
	1F10	1	0	" "
	1L7	0	1	P. staminea
II	1J13	0	2	P. staminea

Obviously more investigation needs to be carried out on this problem. In general, however, in Zones III and IV, use of molluscs appears to have occurred throughout the year. The sparse evidence from Zone II implies use within the period between late spring to fall, but tells nothing about use at other times of the year. No specimens were available from Zone I with which seasonal estimates could be attempted.

Food Value

To assess the amount of "meat" represented by the shell remains, approximately 25 specimens of each dominant species, representing all available sizes, were randomly selected from the alcohol-preserved, live-collected material gathered from near Tofino, B.C., in 1971. The soft parts were removed and the shells and soft parts were weighed separately for each specimen. After dividing the meat weight by the shell weight for each specimen, the resulting ratios were averaged to produce a ratio for each species.

As expected, substantial variation (up to 40%) in these ratios was found within each species. This is attributed to reproduction and growth. Before annual spawning much energy is expended in producing ova, and after spawning the relative weight of the soft parts will be much less than before spawning. Old specimens are also often relatively thin-bodied when compared with young specimens. Finally, during periods of phytoplankton abundance the soft parts of filter-feeding molluscs will be relatively heavier than during periods of phytoplankton scarcity.

Sufficient agreement within each species occurred to permit the calculation of approximate conversion factors for transforming shell dry weight to corresponding meat wet weight in each discrete group. These are as follows: Tresus nuttalli, 0.86; Saxidomus gigantea, 0.50; Protothaca staminea, 0.40; Mytilus californianus, 0.40; Nucella lamellosa, 0.12; chitons, 4.7; barnacles, 0.15. The conversion index for chitons is an average of conversion indices derived for both of the species separately and the conversion index for barnacles was derived from weighing specimens attached to live-collected M. californianus. A conversion index of 0.46 was used for the "unidentified fragments and miscellaneous" category. This is an approximate value derived from averaging the conversion indices of the five dominant species listed above.

This procedure does not utilize the minimum-number method ordinarily employed in archaeological interpretation. In such a procedure the minimum number of left valves, both whole and reconstructed from fragments, would be compared with the minimum number of right valves, whole and reconstructed, in each grid level sample and the larger quantity would be considered equivalent to the minimum number of specimens represented in the sample. In the present case, the weight conversion method was considered to be more accurate because it takes into account all the fragmentary remains that are more numerous than those of complete shells and valve fragments with hinges. The relative reliability of each method, however, needs to be evaluated.

Table 3 shows the dry shell weights and Table 4 the "meat" equivalent of the total shell weights of each mollusc within each zone (Fig. 5). Cemented material has been omitted.

Table 3. Shell Weights (Grams) of Predominant Mollusc Species by Stratigraphic Zone

Zone	Infaunal Species			Epifaunal Species		Chitons	Barnacles	Miscellaneous Species and Unidentified Fragments	Totals
	T. nuttalli	S. gigantea	S. staminea	M. californianus	N. lamellosa				
IV	6,897.3	67,667.8	42,181.8	18,400.5	2,500.4	142.5	1,740.5	4,048.3	123,539.1
III	519.8	912.6	409.5	9,189.7	2,767.9	7.7	489.3	626.1	14,917.6
II	93.8	388.7	192.5	11,077.0	4,090.4	0.4	441.4	1,596.8	17,881.0
I	1.8	50.7	3.7	216.9	18.8	1.0	4.8	6.1	303.8

Table 4. Estimated Meat (Grams) Represented by Shellfish Remains

Zone	Infaunal species			Epifaunal Species		Chitons	Barnacles	Miscellaneous Species and Unidentified Fragments	Total
	T. nuttalli	S. gigantea	S. staminea	M. californianus	N. lamellosa				
IV	5,699.27	30,030.71	19,872.72	7,360.20	300.40	669.75	261.07	1,862.20	63,254.33
III	447.00	456.30	163.80	3,675.88	332.14	36.19	73.39	288.00	5,472.72
II	80.66	196.35	77.00	4,430.80	490.84	1.88	66.21	734.52	6,076.26
I	1.54	25.35	1.48	86.76	2.25	4.70	0.72	2.80	125.60

Many of the clam shells from Zones III and IV exhibit characteristic chipped and broken edges, and therefore appear to have been opened by force. In many specimens rectangular pieces have been broken away from the mid-ventral margins. This is what would happen if a living, tightly-closed clam had been opened by prying the valves apart with a sharp instrument. If the clams had been roasted, they would have gaped open, and this kind of breakage would not have occurred. Experience has shown that if empty disjoined clam shells are broken by being trampled upon or by other non-selective means, the whole shell is broken into two or more large pieces and marginal chips like those in the archaeological material are most unlikely to occur.

In Zone I, needle-like prisms of blue shell material, presumably Mytilus, were abundant. This is what one would expect if the mussels were roasted because the conchyolin matrix of the shells would be burned away. None of the molluscs from any zone appeared to be charred.

Unfortunately, it is impossible to come to any conclusion regarding the number of inhabitants of Yuquot during the 4000-year known period of occupation of the site. The total food weight represented by all of the shellfish remains is nearly 75,000 grams (about 337 lbs.). If the excavated portion represents approximately 3% of the entire midden, as has been estimated (Dewhirst, personal communication), then the total food weight represented by molluscs in the whole midden is about 11,200 lbs.

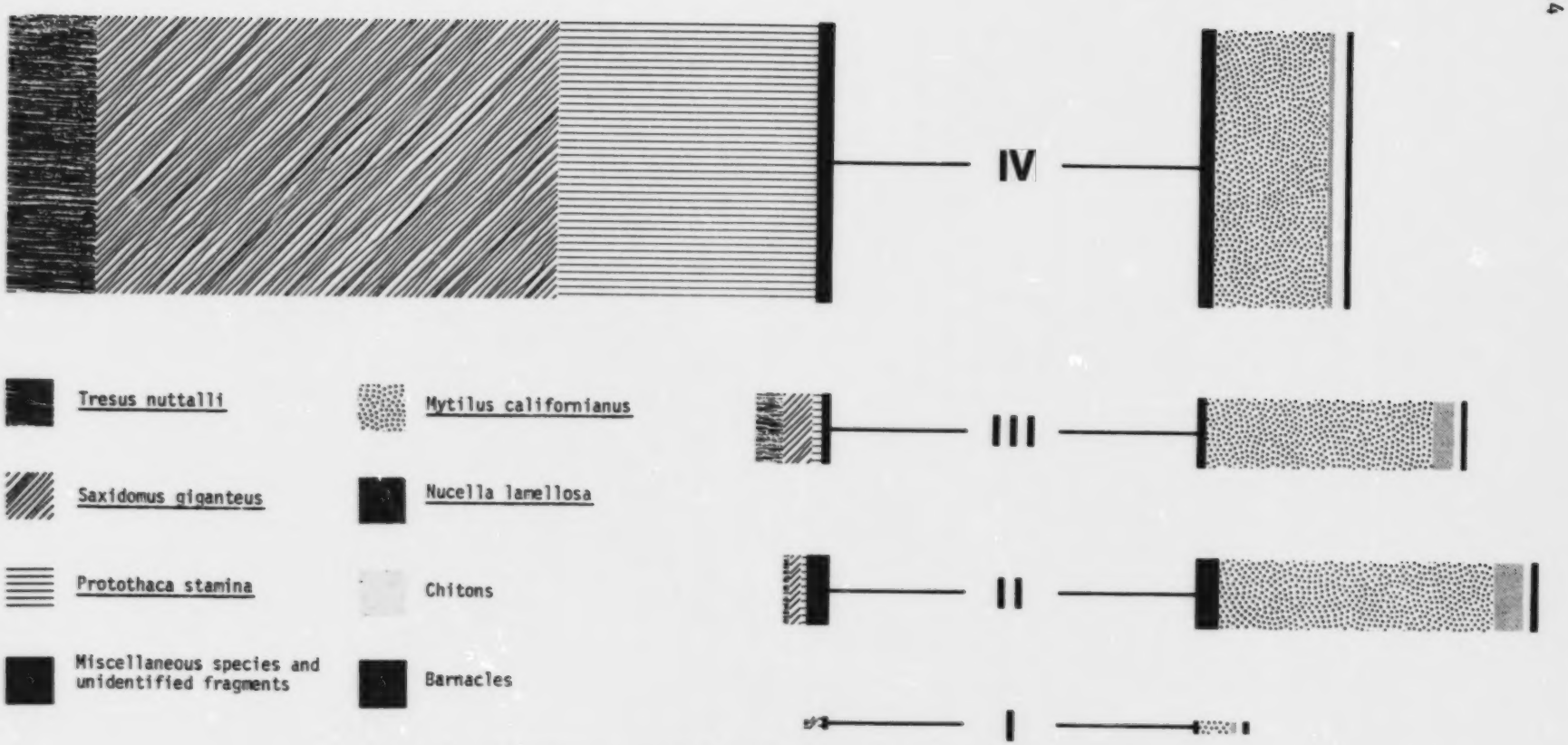


Fig. 5. Relative quantities of meat estimated for infaunal and epifaunal species collected from each stratigraphic zone. Bar areas are proportional to grams of meat.

Summary

1. Ninety-six cubic feet of mixed bone and shell material was recovered from the Yuquot excavation. Shellfish made up 35% of these faunal remains. Molluscs constitute 99.4% of the shellfish and barnacle plates constitute 0.6%.

2. Thirty-nine species of marine molluscs and three species of terrestrial molluscs were present. The dominant species are two intertidal marine species which live on rocks ("epifauna"), viz. Mytilus californianus and Mucella lamellosa, and three intertidal marine species which live in sand ("infauna"), viz. Protothaca staminea, Saxidomus gigantea, and Tresus nuttalli.

3. Despite the fact that the deposits span more than 4000 years of occupation, the shellfish provide little evidence of climatic changes. All of the species found also occur alive in British Columbia at present.

4. Epifaunal species are dominant in lower levels of the site but infaunal species, chiefly clams, are dominant in the upper levels. The faunal transition is closely concordant with the stratigraphic transition from the prehistoric to the historic period of occupancy. Some other faunal shifts also occur.

5. It is concluded that overhunting and local extinction of the sea otter, an event which occurred about 1790, relieved predator pressure on clams in the region and enabled them to become much more abundant. This is proposed as the explanation for greatly increased infaunal abundance in Zone IV.

6. Difficulties of interpretation make estimates uncertain, but it appears that shellfish were harvested throughout the year during deposition of Zone III and Zone IV, i.e. since about A.D. 800. Meagre evidence suggests summer use in Zone II (1000 B.C. to A.D. 800) but does not rule out winter use. No seasonal estimates are possible for Zone I (pre-2300 B.C. to 1000 B.C.).

7. Many clam shells from Zone III and IV show evidence of having been opened by force.

8. The shell remains are equivalent to about 337 lbs. of shellfish meat and the whole midden therefore represents about 11,200 lbs. of shellfish-derived food.

9. A few shell artifacts (celts, pendants, and a knife) occur in Zones II, III and IV. Two fragments of the monetary mollusc Dentalium also occurred near the base of Zone IV.

References Cited

Abbott, R.T. 1954. American Seashells. D. van Nostrand Co., New York.

Bernard, F.R. 1970. A distributional checklist of the marine molluscs of British Columbia: based on faunistic surveys since 1950. Syesis Vol. 3, pp. 75-94. Victoria.

Clarke, Louise R. and A.H. Clarke. 1975. Mollusk utilization by Nootka Indians, 2300 B.C. to A.D. 1966. Bulletin of the American Malacological Union, Inc., 1974, pp. 15-16.

Dewhirst, John. 1980. The Indigenous Archaeology of Yuquot, A Nootkan Outside Village. National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, No. 39, The Yuquot Project, Vol. 1.)

Drucker, Philip. 1951. The Northern and Central Nootkan Tribes. Bureau of American Ethnology Bulletin 144. Smithsonian Institution, Washington.

---. 1963. Indians of the Northwest Coast. American Museum of Natural History, New York.

Estes, J.A. and J.F. Palmisano. 1974. Sea otters: their role in structuring nearshore communities. Science Vol. 185, No. 4156, pp. 1058-60.

Folan, William J. 1969. Yuquot, British Columbia: the Prehistory and History of a Nootkan Village, Part 1, Introduction and Ethnohistory of the Village. Northwest Anthropological Research Notes Vol. 3, No. 2, pp. 217-31.

Folan, William J. and John T. Dewhirst. 1970. Yuquot: Where the Wind Blows from All Directions. Archaeology Vol. 23, No. 4, pp. 276-86.

Fraser, C.M. and G.M. Smith. 1928a. Notes on the Ecology of the Little Neck Clam, Paphia staminea Conrad. Transactions of the Royal Society of Canada, Section 5, pp. 249-69.

---. 1928b. Notes on the Ecology of the Butter Clam, Saxidomus giganteus Deshayes. Transactions of the Royal Society of Canada, Section 5, pp. 271-77.

Keen, A. Myra. 1937. An Abridged Check List and Bibliography of West North American Mollusca. Stanford University Press, Stanford.

Kenyon, K.W.. 1969. The Sea Otter in the Eastern Pacific Ocean. North American Fauna, No. 68, Govt. Printing Office, Washington.

Moziño, José Mariano. 1970. Noticias de Nutka. An Account of Nootka Sound in 1792. (Translated and edited by Iris Higbie Wilson). University of Washington Press, Seattle.

Quayle, D.B. 1970. The Intertidal Bivalves of British Columbia. British Columbia Provincial Museum Handbook No. 17. Victoria.

Rice, Tom. 1972. Marine Shells of the Pacific Northwest. Ellis Robinson Publishing, Seattle.

Simenstad, C.A., J.A. Estes, and K.W. Kenyon. 1978. Aleuts, Sea Otters and Alternate Stable State Communities. Science, Vol. 200, pp. 403-11.

Zooarchaeological Analysis of Barnacle Remains from Yuquot, British Columbia

Judith A. Fournier and John Dewhirst

60 Abstract
61 Acknowledgements
62 Introduction
66 Identification
93 Analysis
100 Summary
101 References Cited

Abstract

In this paper we present a zooarchaeological analysis of more than 1400 remains of barnacles excavated from the midden of the Nootkan village of Yuquot. The methods of identifying barnacle remains, particularly by "figures in the shell," are reviewed and applied to the archaeological specimens. Three main species were identified: Balanus nubilus Darwin, Semibalanus cariosus (Pallas), and the whale barnacle, Coronula reginae Darwin. Analysis reveals that the first two species were a source of food at Yuquot since at least as early as ca. 200 B.C., with increased use of B. nubilus in the historic period. Coronula reginae was found to be a useful archaeological indicator of humpback whale, Megaptera nodosa, utilization. Such potential as archaeological indicators is suggested for other whale barnacles with species-specific substrata. Notable species absent from the archaeological sample are discussed, and some recent ethnographic information on barnacles is presented.

Submitted for publication 1978, by Judith A. Fournier, National Museum of Natural Sciences, Ottawa, and John Dewhirst, National Historic Parks and Sites Branch, Parks Canada, Cornwall.

Acknowledgements

The National Museum of Natural Sciences made available to us specimens of Balanus nubilus and Semibalanus cariosus for comparative purposes. We are grateful to Mrs. Fahmida Rafi for loaning us the specimens, and to Dr. E.L. Bousfield for identifying the specimen of B. nubilus that was used for reference purposes. Dr. Nishi Sharma, under contract to the National Museum of Natural Sciences, sorted, weighed, and identified the majority of the archaeological specimens. Dr. Alex Peden of the British Columbia Provincial Museum kindly arranged for the collection of fresh S. cariosus and B. nubilus. These specimens were collected and processed by John Edwards, Janice Gardner, and Anne Stewart. The Conservation Division, National Historic Parks and Sites Branch, processed the fresh specimens to obtain a constant dry shell weight. Mr. Angus MacDonald, Department of Energy, Mines and Resources, prepared the thin sections of B. nubilus from the fresh specimens.

We owe much in writing this report to valuable suggestions from Dr. Daniel J. Faber and Mrs. Diana R. Laubitz, Canadian Aquatic Identification Centre, National Museum of Natural Sciences, Ottawa; and from Mr. John H. Rick, Research Division, National Historic Parks and Sites Branch, Parks Canada, and Mr. Jervis D. Swannack, also of Parks Canada.

Introduction

Although barnacles on the Northwest Coast have long been known as a food source for native peoples (for example, Boas 1921: 499-506; Drucker 1951: 39; Cornwall 1955: 17; Carl 1963: 116; Drake 1963; Ellis 1976: 20-21, 35-36), the actual species used and their biological and cultural significance are little known. In this paper we explore these problems through a zooarchaeological analysis of more than 1400 barnacle remains from the midden of the Nootkan village of Yuquot. The analysis is interpreted in light of recent Nootkan ethnographic data.

The barnacle remains were studied initially by Louise R. Clarke and Arthur H. Clarke, who discussed them generally in the Yuquot mollusc report (1974). As barnacles are not molluscs, and circumstances did not permit an equally detailed analysis of the barnacle remains, the Clarkes recommended further study. This paper, then, complements the Clarkes' mollusc analysis and completes the study of all the Yuquot invertebrate remains.

In the course of this analysis, methods used to identify fossil and archaeological remains of barnacles, in particular "figures in the shell" (Cornwall 1956, 1958, 1959), were applied and refined concerning the two major species found archaeologically. One controversial species, Balanus altissimus Cornwall, was found to be a variant of B. nubilus Darwin. The barnacle shell structure of distinctive interlocking plates (Fig. 1-3) makes analysis by methods used for vertebrate fauna appropriate. Such an analysis is applied here to the barnacle remains. Examination of the whale barnacle, Coronula reginae Darwin, suggests that whale barnacle species with species-specific substrata may indirectly indicate utilization of certain whale species.

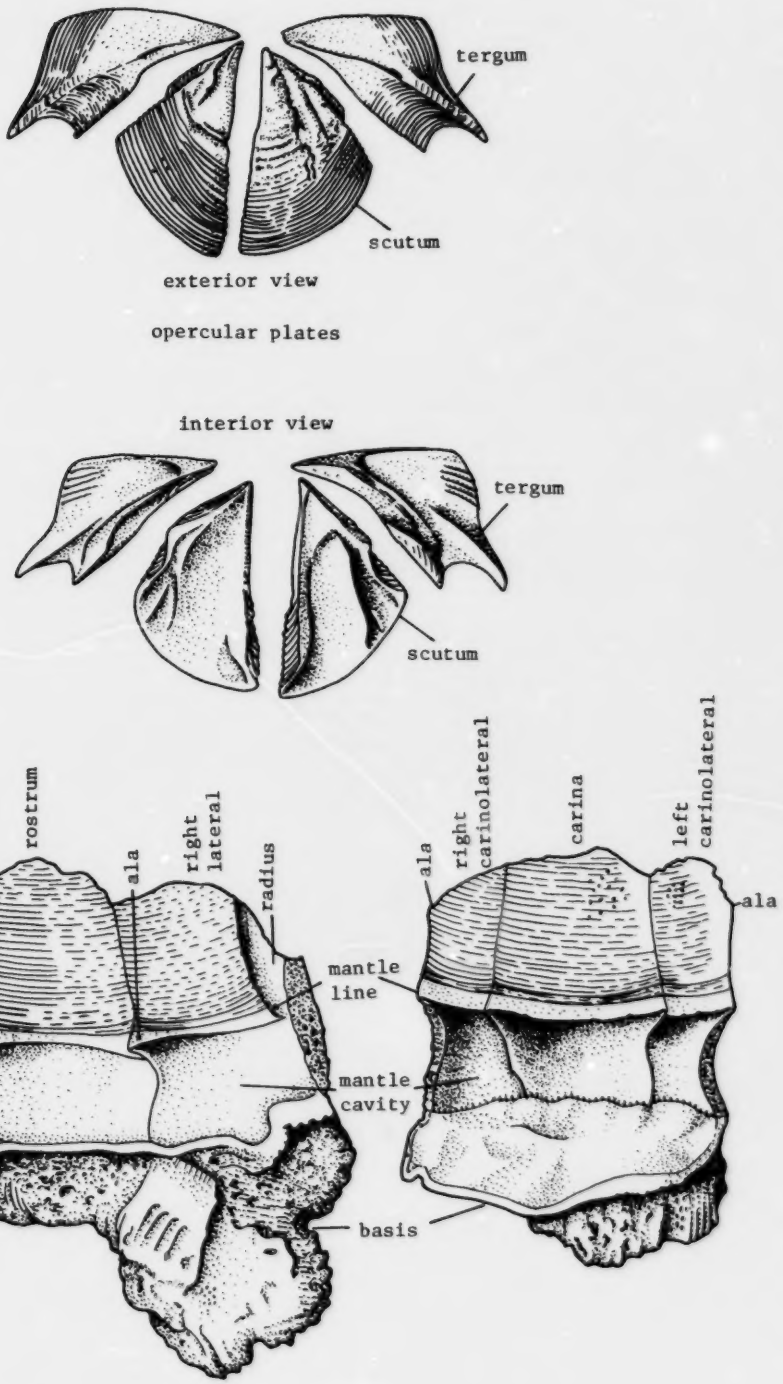


Fig. 1. Balanus nubilus: diagrammatic representation of the opercular plates and interior view of the interlocking plates of the body wall and basis. (Drawing by Sally Gadd.)

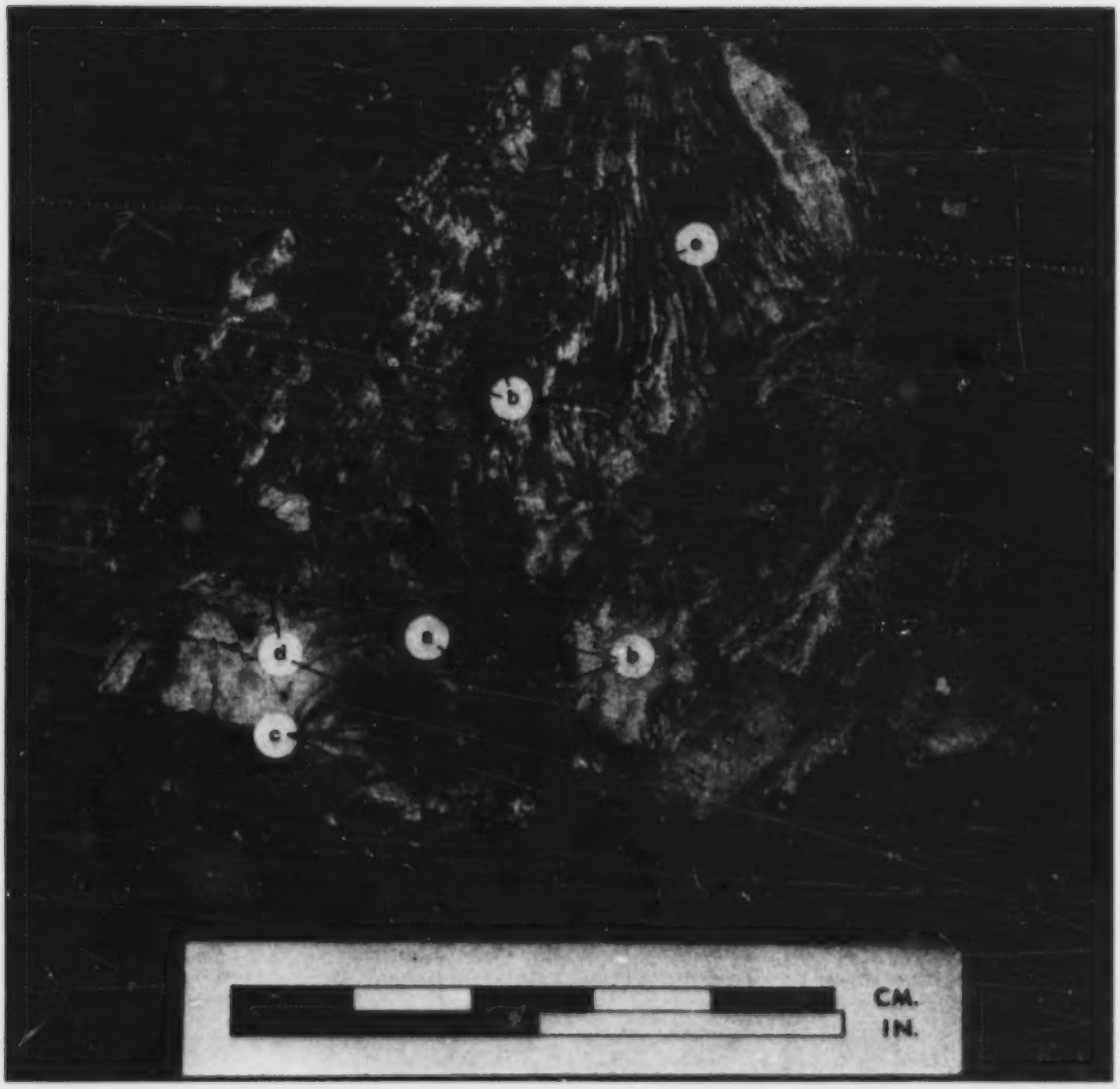


Fig. 2. B. nubilus: lateral view of freshly collected specimen showing extensive epifauna. (a) Bryozoa, (b) polychaete tubes, (c) polychaete holes, and (d) young barnacles. Body wall has eroded in the grooved area exposing the parietal tubes (e). (Photo by R. Chan.)

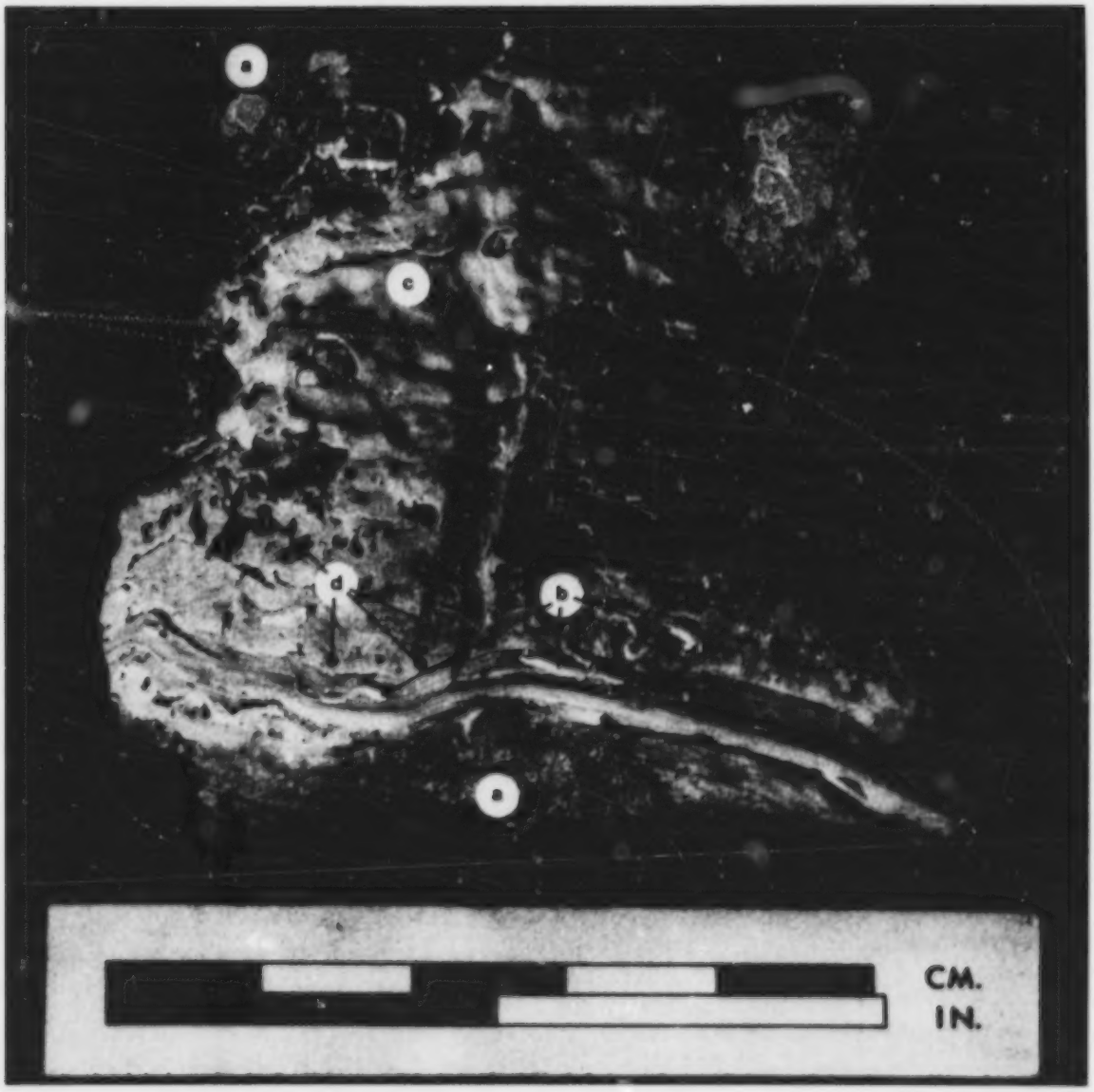


Fig. 3. B. nubilus: opposite lateral view of specimen in Fig. 2 showing (a) bryozoa, (b) polychaete tubes, (c) corraline alga, and (d) bull's-eye-like scars of the boring sponge Cliona.

Identification

The method of species identification used was that outlined by Cornwall (1956, 1958, 1959) for fossil and recent barnacles. This is based on recognition of species-specific interlaminate figures or patterns revealed by sections of the shell (Fig. 8-11). In the course of applying this method, some difficulties were encountered that brought into question the distinctiveness of "figures in the shell" and their value alone in identifying certain species. The archaeological nature of our sample and analysis also required some modifications in the identification procedure.

Before sectioning, each intact shell, unattached plate, and plate fragment was labelled with India ink with regard to provenience (Fig. 14), and then weighed on a balance (Mettler H10T). Whenever a number of fragments were present, an attempt was made to fit them together to determine which, if any, plates came from the same animal. This was occasionally successful with the Balanus and Semibalanus specimens, and very successful with the Coronula, whose fragments were rejoined with glue (Krazy Glue) (Fig. 24-26). When plates could be rejoined to assemble a complete or nearly complete animal, these were recorded as whole animals. Fragments that could be identified as a specific plate were so recorded (Fig. 14, 22).

Barnacles are very "popular" with a large number of commensal, symbiotic, and parasitic organisms that colonize the external features of the relatively soft, calcareous shell of living animals. These colonizers include boring organisms such as the sponge Cliona; various polychaetes such as Polydora, tube building worms of the families Sabellidae and Serpalidae; various species of hydroids; bryozoans; other barnacles; and algae (Fig. 2, 3, 19). A living barnacle can maintain the integrity only of its mantle cavity (Fig. 6). As soon as the barnacle dies, the boring organisms begin to penetrate the surfaces of the mantle cavity as well (Fig. 16, 17, 22).

In recording barnacle remains for archaeological analysis, it is therefore essential to distinguish those of animals alive at capture from those of animals dead at capture. Living barnacles are often found surrounding one or more dead shells of the same species. Thus, those dead at capture were probably collected incidentally along with the living. Bryozoa and other organisms on the surface of the mantle cavity or polychaete (worm) holes penetrating the mantle cavity indicate animals dead at capture (Fig. 16, 17, 22). Therefore, the presence of such organisms was also noted.

Many plates and fragments were observed to have wood ashes sticking to them and were so noted. Any indications that the shells had been scraped or pried from their substrata were also recorded.

Fragile shells were first soaked in benzyl alchohol to make them resistant to shattering during sectioning. On the larger specimens of B. nubilus, an emery cutting wheel (Dremel Moto-tool, model 260) was

used to make horizontal cuts in the shell (Fig. 4, 5, 12, 13). The polished edge left from cutting was then moistened with benzyl alcohol and it readily showed the characteristic patterns (Fig. 5, 8-11, 13). The bases of smaller shells were ground carefully against a piece of sharpening stone until the parietal tubes became apparent and then were polished with an emery-coated nail file. The sharpening stone and nail file were also used to expose patterns in the alae.

After initial grinding and cutting, the specimens were mounted in plasticine so that the exposed surfaces could be examined under a binocular dissecting microscope. The lighting was adjusted to illuminate the figures to the best possible advantage. When necessary, a 2X objective lens was used to magnify the figures 100 times. The reduced working distance of this lens was also useful for focussing in on very large specimens.

For comparative purposes, a number of specimens of the two most common species, B. nubilus Darwin and Semibalanus cariosus (Pallas), were borrowed from the invertebrate collection of the National Museum of Natural Sciences. The patterns and structure of these shells were used as reference material for verifying the identifications of the archaeological barnacles.

Cornwall (1956, 1958, 1959) is very enthusiastic about the value of the "interlaminate figures in the shell" (for example, Fig. 8-11), and details the various figures found in a number of species. From our experience, these figures are useful for identifying fragments and fossil barnacles, but they must be used with caution.

One drawback to using shell figures is that many species do not have them. These include most of the pedunculate species and the genus Semibalanus (Newman and Ross 1976). In S. cariosus, the parietal tubes are numerous and of various diameters, giving the cross section of the shell a sponge-like texture (Pilsbry 1916). Fortunately the parietal tubes are highly characteristic (Fig. 20-22), and S. cariosus is the only large barnacle with a membranous base found on the British Columbia coast. In addition, many of the archaeological fragments showed the rough external sculpture characteristic of "typical" specimens of S. cariosus (Fig. 19). (Semibalanus balanoides Linnaeus has been recorded from Alaska and Puget Sound, but this species is rare and much smaller than S. cariosus.) Semibalanus cariosus is thus a readily recognizable species.

Another problem with shell figures is that they are not as constant within a species, or even within a single animal, as Cornwall implies. Almost all the archaeological specimens of B. nubilus showed the pattern figured for B. altissumus (Cornwall 1936). These specimens were assigned on this basis to B. altissimus, until we received the fresh specimen of B. nubilus. The inner shell structure, the cover plates, and the structure of the cirri and mouth parts agreed with B. nubilus (Pilsbry 1916), but the shell pattern resembled the figure for B. altissimus (Cornwall 1936). Not all of the patterns exposed on the small section of the shell were the same, however, so the shell was cut all the way around, and its entire perimeter was examined. This revealed patterns resembling not only B. nubilus and B. altissimus, but also B. tintinnabulum californicus Pilsbry, B. regalis Pilsbry, and B. psittacus (Molina). It is obvious, therefore, that the shell figure alone cannot be regarded as a definitive diagnostic feature.

It was also apparent that the status of B. altissimus was doubtful. This species was erected by Cornwall (1936) as an intertidal species

closely related to B. nubilus, but differing in the structure of the basis, the spination of cirrus VI, and the arrangement of nerves in the oesophageal collar. Subsequently, B. altissimus was synonymized with B. nubilus by Henry (1942), who could find no constant differences between littoral and dredged specimens. Cornwall (1955) suggested that altissimus might be an environmental form of nubilus, and then, on the basis of the shell figures, resurrected altissimus as a species (1958). Our results have forced us to accept the views of Henry (1942) and Dr. E.L. Bousfield (personal communication). Balanus altissimus is, at most, a variety of B. nubilus, possibly influenced morphologically by environmental factors.

Identification of the archaeological specimens assigned to B. nubilus is therefore based not only on the general shell figures, but also on the inner sculpture of the shell (when present) (Fig. 4, 5), the characteristic sculpture (Fig. 5) of the basal portions of the parietal tubes (Pilsbry 1916), and the few cover plates (terga and scuta) (Fig. 11) recognized as belonging to B. nubilus. Of the three similar species mentioned, B. psittacus is found on the South American coast from Tierra del Fuego to Peru; B. regalis and B. tintinnabulum californicus are found in Baja, California, the latter as far north as San Francisco. We are thus reasonably confident of the identification B. nubilus.

The other two species of Balanus found, B. glandulus Darwin and B. crenatus Brugière, were each encountered once among the archaeological remains and then only as scattered fragments. Both identifications are based strictly on the interlaminate figures and are thus considered tentative; fresh specimens were unavailable for comparison. Both species are commonly associated with S. cariosus along the British Columbia shoreline.

The whale barnacle, Coronula reginae Darwin, was found several times. The characteristic shape, structure, and surface sculpture of the shell (Fig. 23-26) were used to identify this species.

The archaeological sampling included all faunal remains. The archaeological barnacle remains totalled 1451 specimens. Identifications of these with regard to species and plate, with distribution by stratigraphic zone, are presented in Table 1. Analysis of the excavation strata (Dewhirst 1980) defined four zones, numbered from lowest to highest as I to IV. Zone I, 2300 B.C. to 1000 B.C., contained few remains, owing to poor preservation. Zone II, 1000 B.C. to A.D. 800, with bulk of deposition after 200 B.C., had good preservation and appears to have formed largely from household activities. Zone III, A.D. 800 to 1790, was likely produced by activites related to households. Zone IV, A.D. 1790 to 1966, contained all historic period deposits and the best preserved remains. Interzone comparisons can be made only relatively, rather than absolutely, because of differential preservation, different sample sizes, and undetermined cultural factors influencing formation of strata.

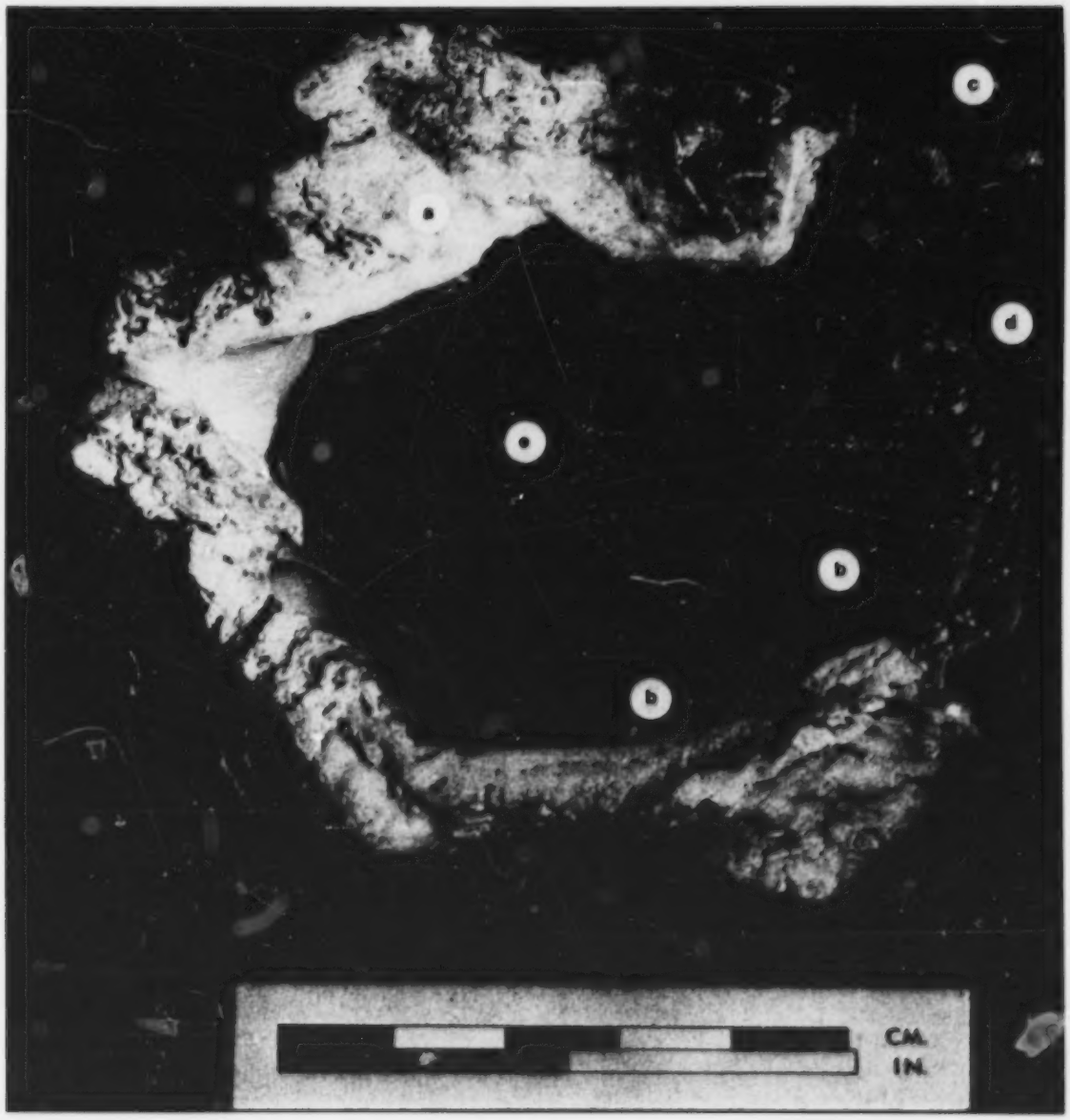


Fig. 4. B. nubilus: ventral view of specimen in Fig. 2 and 3. The basis (a) has been partly removed to show (b) the mantle cavity, (c) bases of parietal tubes with typical structure, and (d) the structure of the lateral wall exposed by removal of a portion for thin-section study. The mantle line (e), various lateral plates, and overlapping alae and radii are clearly visible. (Photo by R. Chan.)

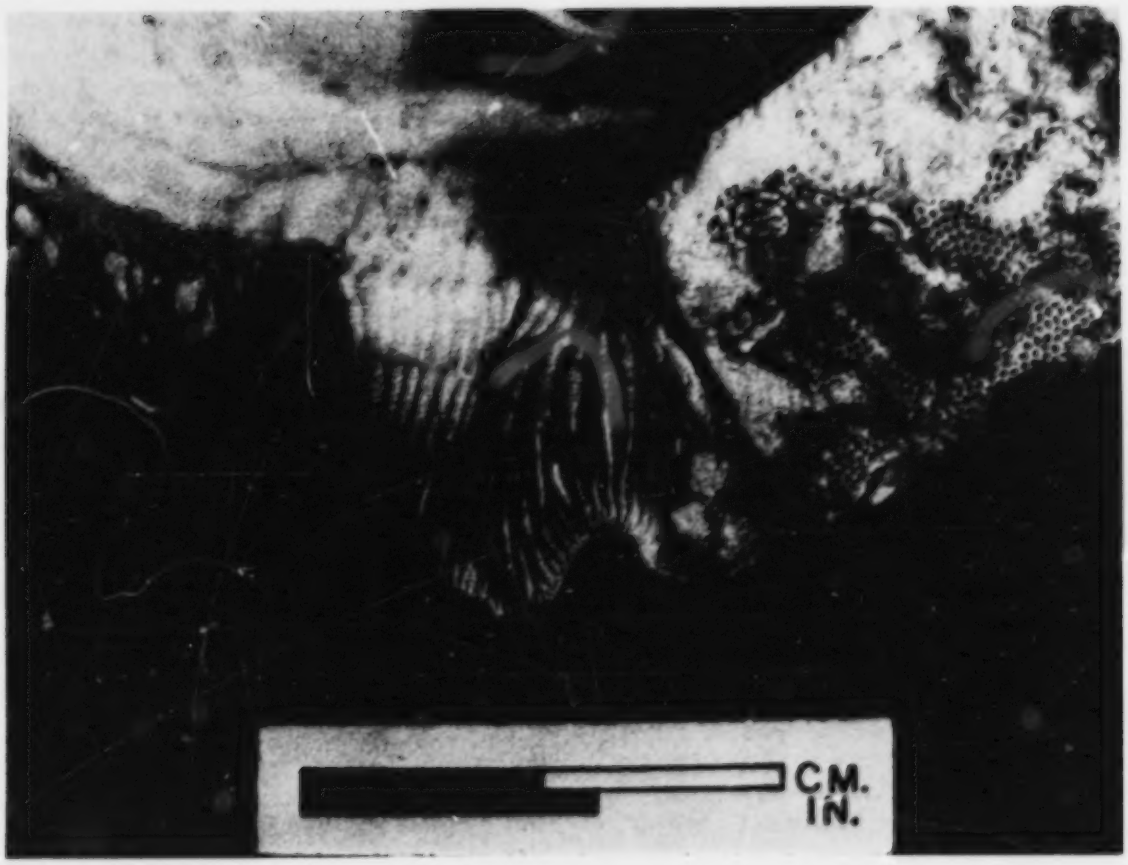


Fig. 5. B. nubilus: close-up of the base of the parietal tubes exposed by sectioning. The mesh-like growth on the basis to the right is bryozoa. (Photo by R. Chan.)

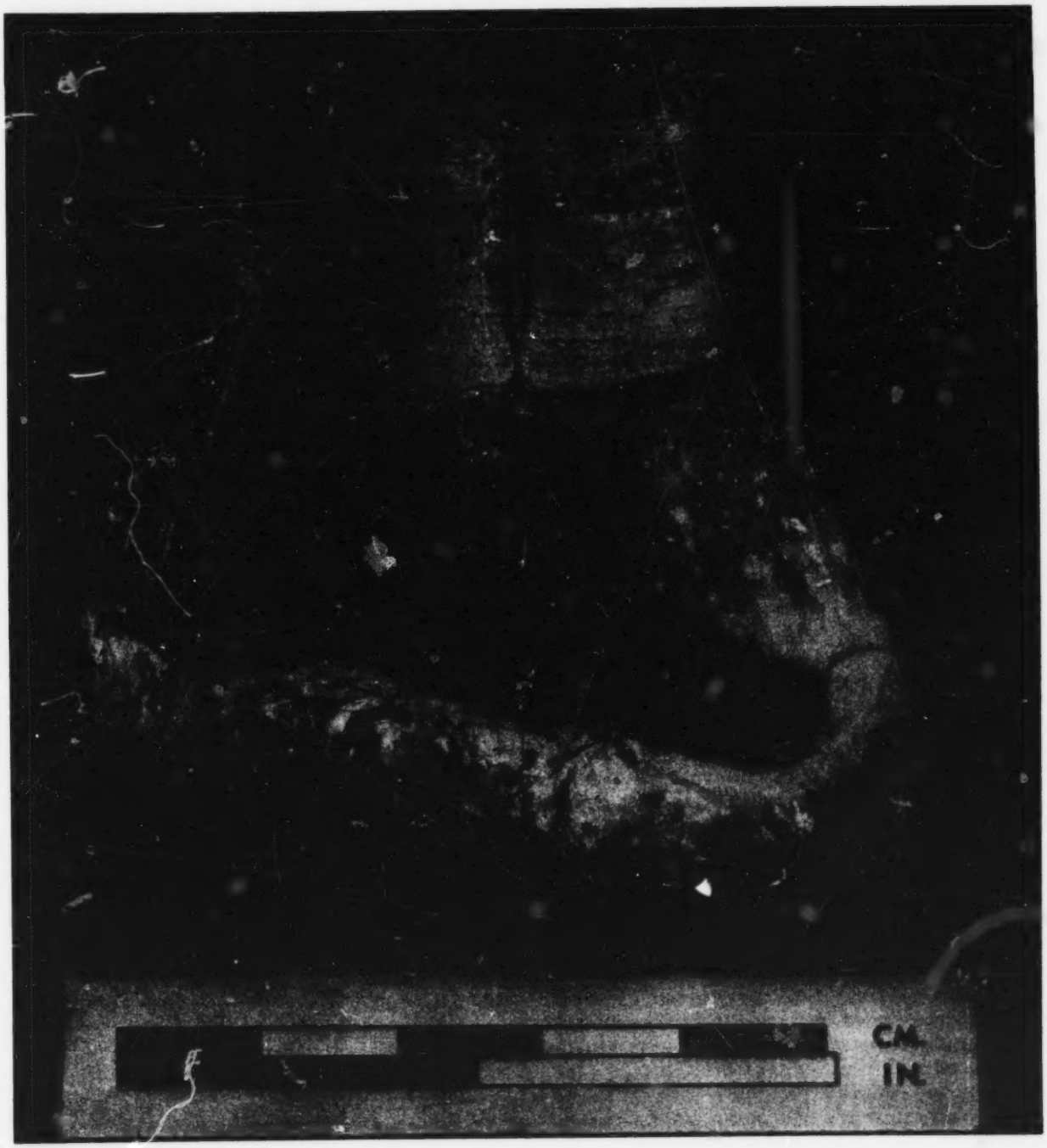


Fig. 6. B. nubilus: interior surfaces of a carina (left) and a carinolateral (right). Portion below the mantle line is free of perforations, although scars from boring organisms are visible. Upper portion of the plates shows bull's-eye-like pits made by the boring sponge Cliona. (Photo by R. Chan.)

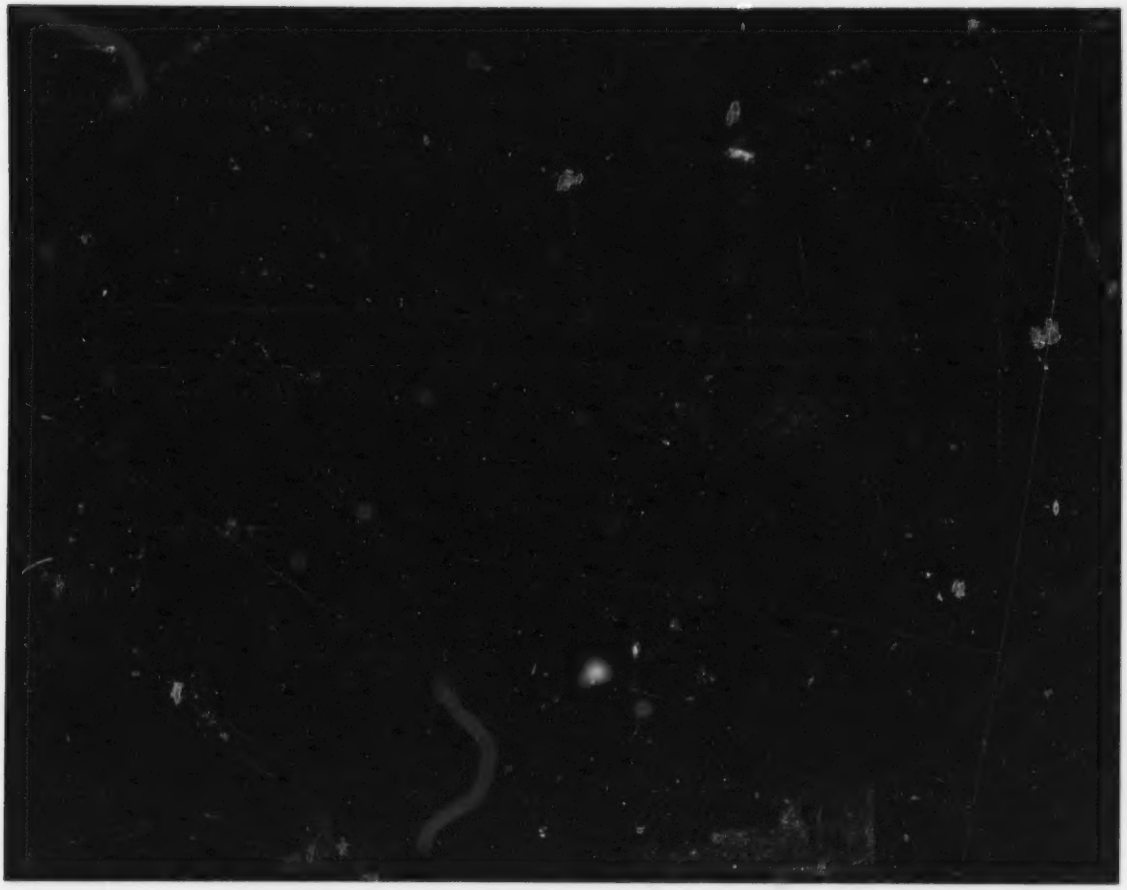


Fig. 7. B. nubilus: opercular plates from a freshly collected specimen; ventral and dorsal views of scuta (left) and terga (right). (Photo by R. Chan.)

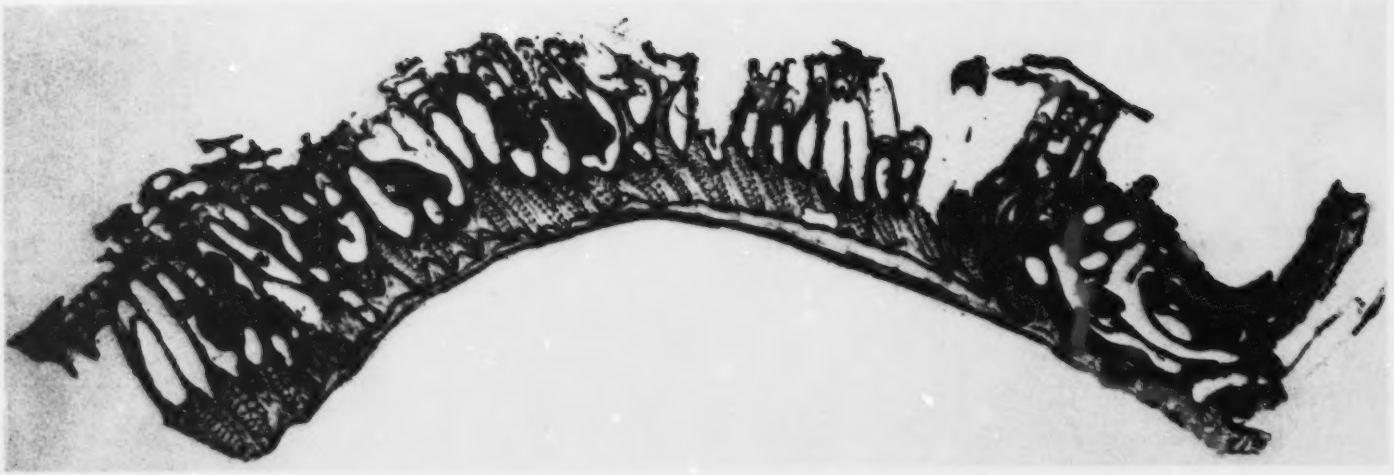


Fig. 8. B. nubilus: thin section of a lateral wall magnified approximately 4.5X showing the characteristic feather-like "figures in the shell" originally described by Cornwall (1955). (Photo by G. Vandervlugt.)

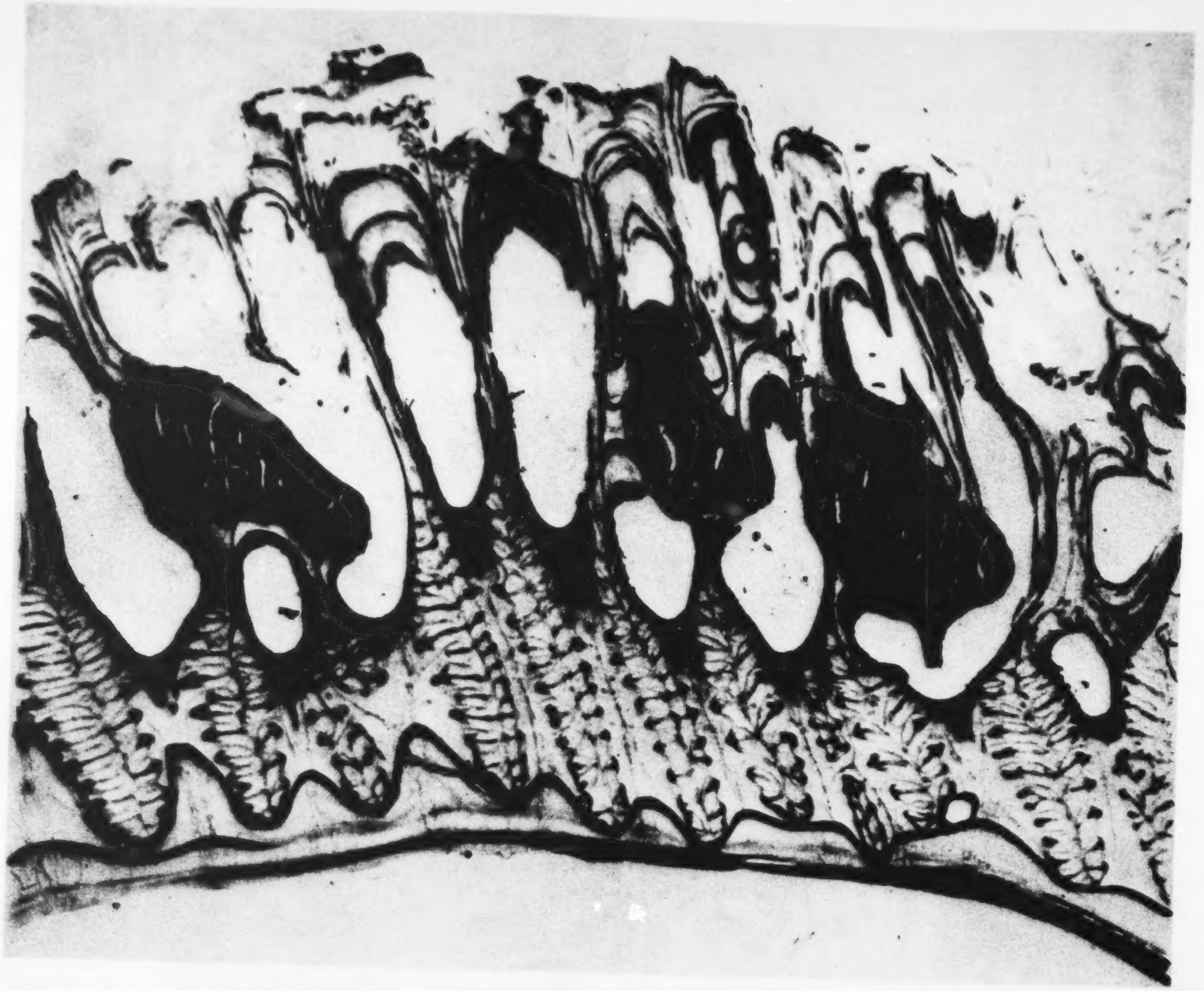


Fig. 9. B. nubilus: a portion of the thin section in Fig. 8 magnified approximately 40X showing fine detail of the feather-like structure and parietal tubes. The edge of the interior surface of the shell is at the bottom. (Photo by G. Vandervlugt.)

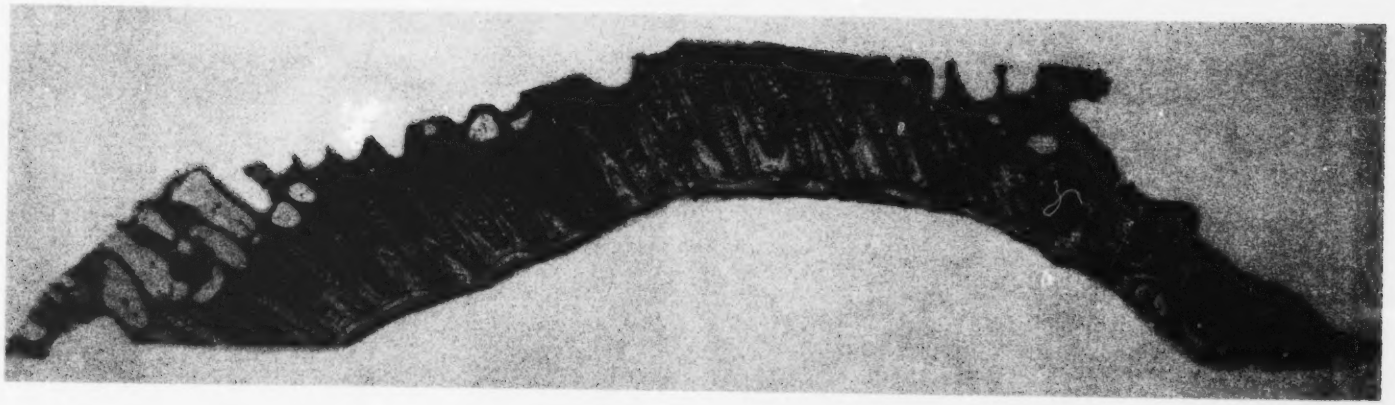


Fig. 10. B. nubilus: thin section of the lateral wall magnified approximately 6.3X showing characteristic structure similar to that in Fig. 8. The parietal tube portion visible in Fig. 8 wore away during the grinding process, but the similarity of the "feather-like" figures is clear. (Photo by G. Vandervlugt.)

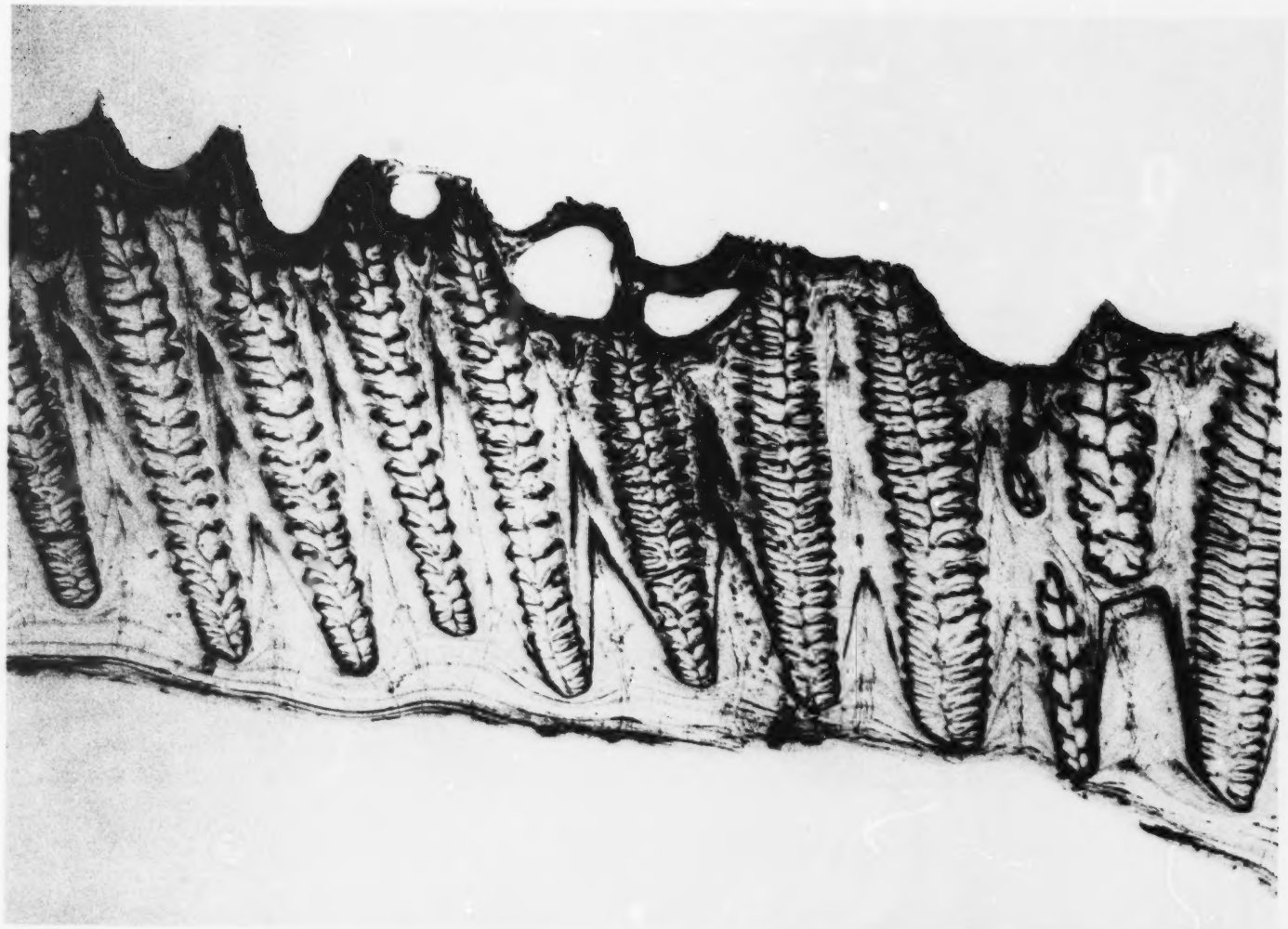


Fig. 11. B. nubilus: portion of a thin section of the lateral wall magnified approximately 34X. Compare with Fig. 9 to see the similarity of "figures in the shell." (Photo by G. Vandervlugt.)

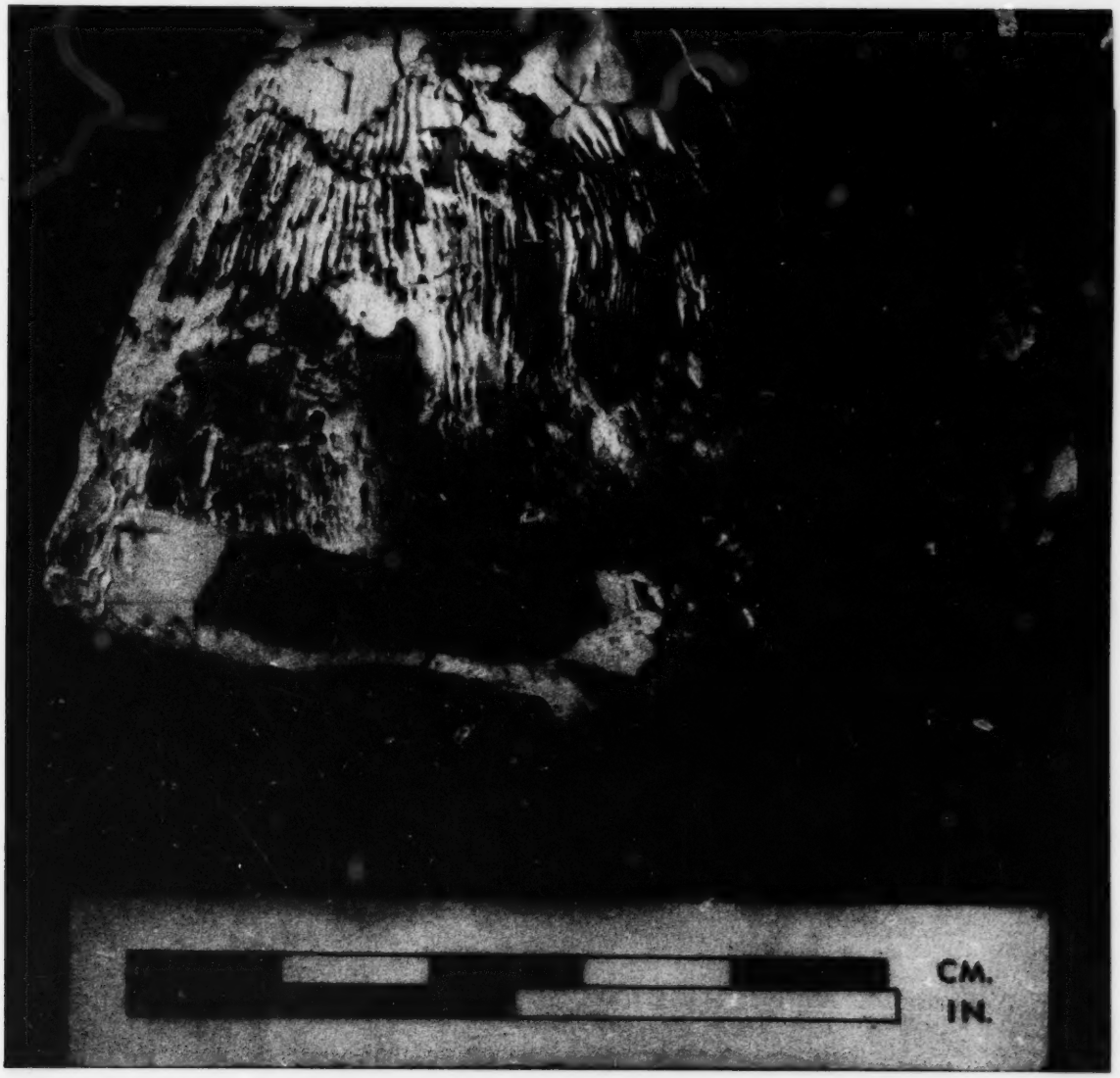


Fig. 12. B. nubilus: lateral view of archaeological specimen 1T2B1A with section cut away to permit examination of parietal tubes. (Photo by R. Chan.)

Fig. 13. B. nubilus: ventral view of archaeological specimen 1T2B1A showing basis, mantle cavity free of perforations, and plates, with section removed to expose parietal tube structure. (Photo by R. Chan.)

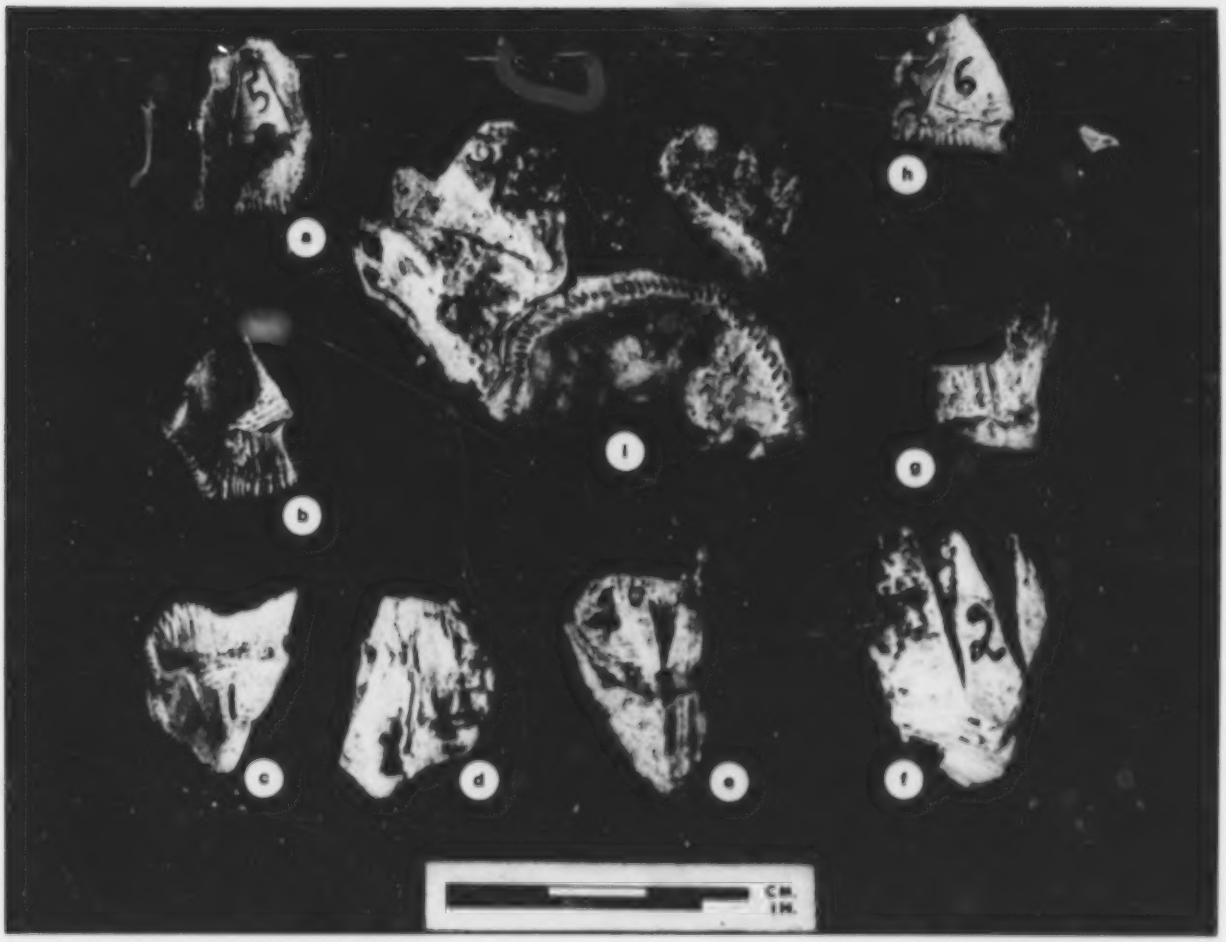
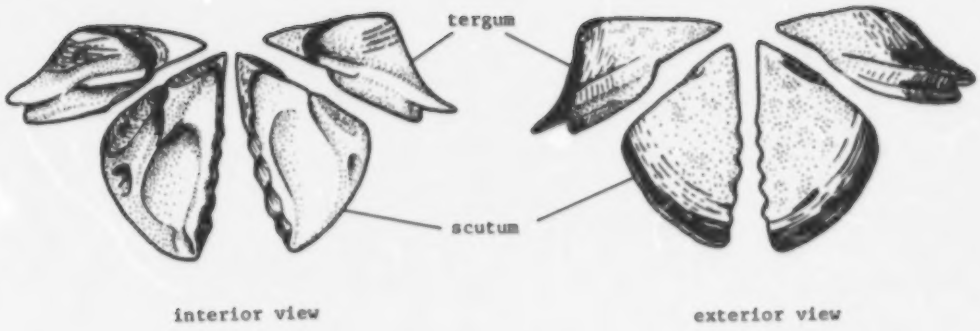


Fig. 14. B. nubilus: archaeological specimens representing several individuals and clumps. (a) Rostrum; (b) carina; (c) left lateral; (d) rostrum, exterior view; (3) a rostrum, right lateral, and basis joined; (f) three-plate fragment with basis, carina, left carinolateral, and left lateral, exterior views; (g) a cup-shaped fragment of basis; (h) right lateral; and (i) clump of one intact animal, one partial animal, and three basal cups. All the above specimens came from animals apparently alive at capture. The numbers visible on some fragments were used to keep track of weights. Two fragments (e, f) carry the number "2" because they fit perfectly together to form one almost intact animal and thus were weighed and counted as one unit. (Photo by R. Chan.)

Fig. 15. B. nubilus: the parietal tubes of rostral fragment (d) in Fig. 14 magnified approximately 10X showing the typical nubilus structure. (Photo by R. Chan.)

Fig. 16. B. nubilus: dorsal view of archaeological specimen 1T3B3B obviously dead at capture. Note the small barnacle growing inside the mantle cavity, the small curl of polychaete tube near barnacle, and numerous worm holes in the surface of the mantle cavity. (Photo by R. Chan.)

Fig. 17. B. nubilus: a lateral plate, archaeological specimen 1T2D16, from an animal dead at capture. Note the numerous worm and sponge holes below the mantle line. (Photo by R. Chan.)



opercular plates

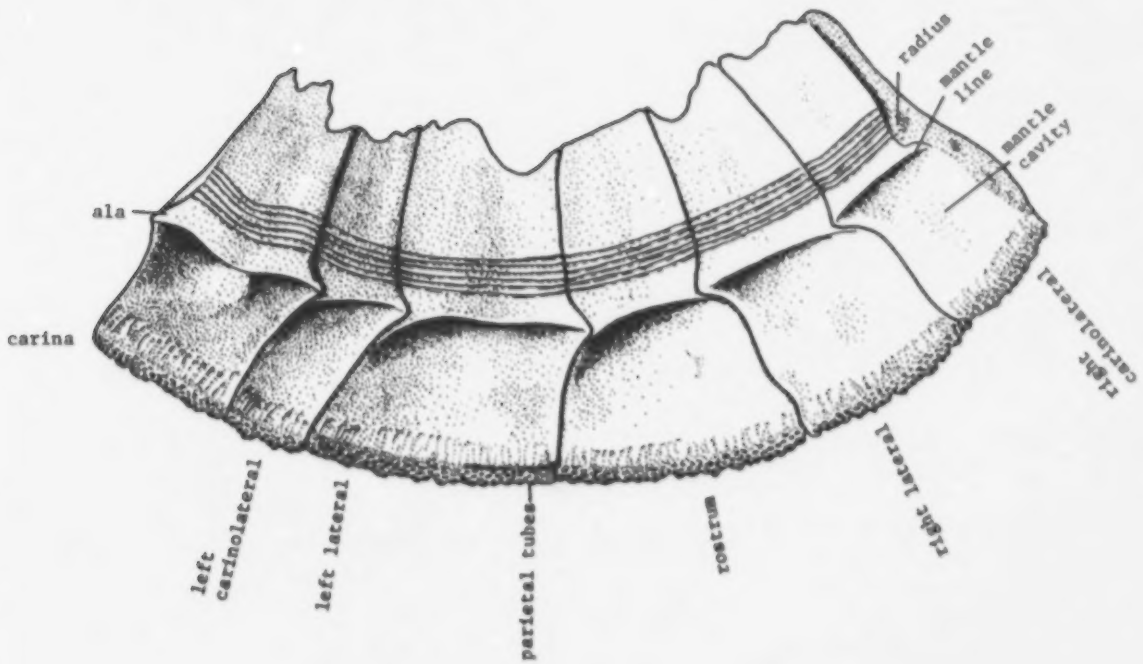


Fig. 18. Semibalanus cariosus: diagrammatic representation of the opercular plates and interior view of the interlocking plates forming the body wall. (Drawing by Sally Gadd.)

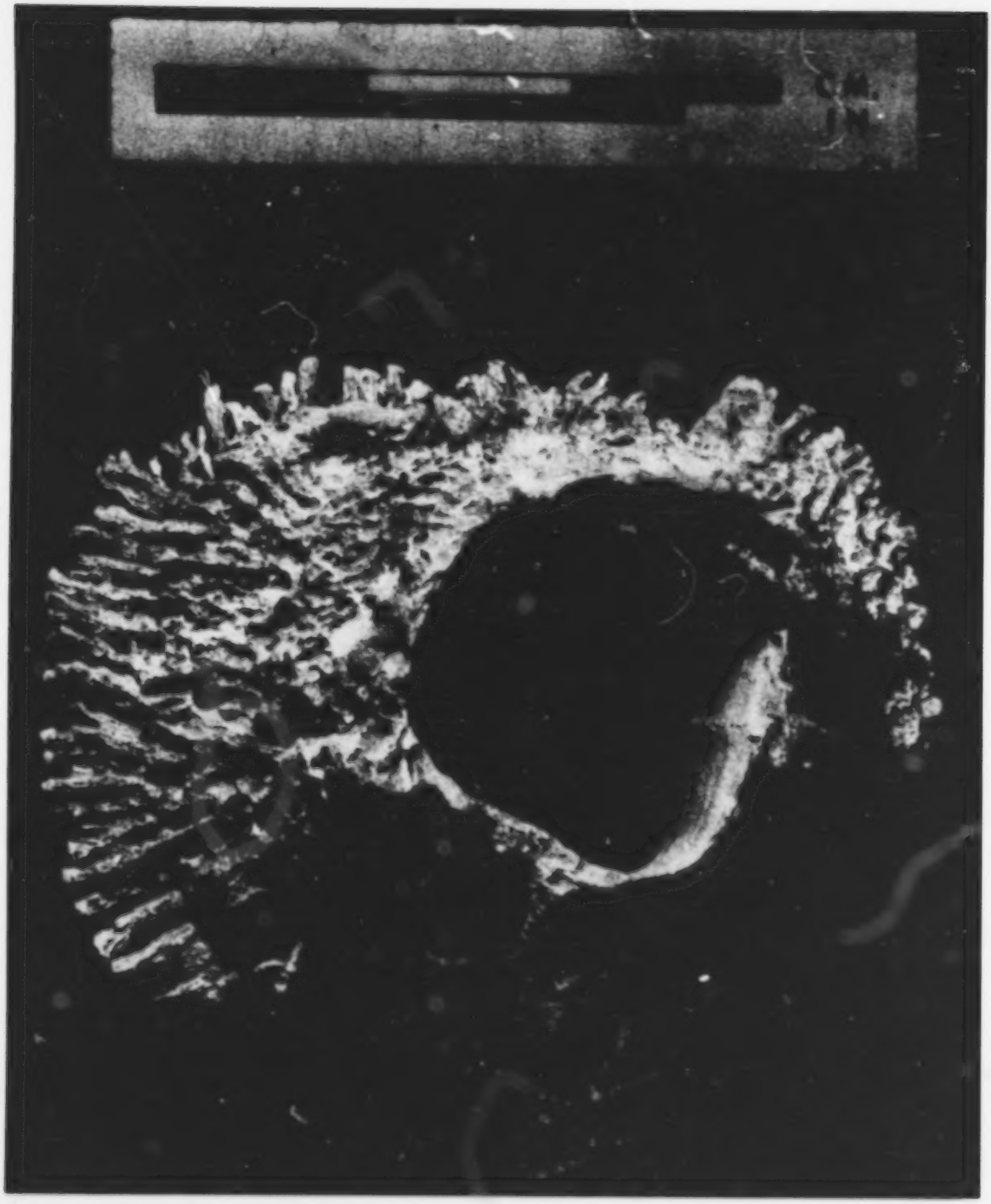


Fig. 19. S. cariosus: dorsal view of a freshly collected specimen showing typical "thatched" surface sculpture. This species lacks a calcareous basis. (Photo by R. Chan.)

Fig. 20. S. cariosus: ventral view of specimen in Fig. 19 showing arrangement of plates, mantle line, and sponge-like texture of parietal tubes. (Photo by R. Chan.)

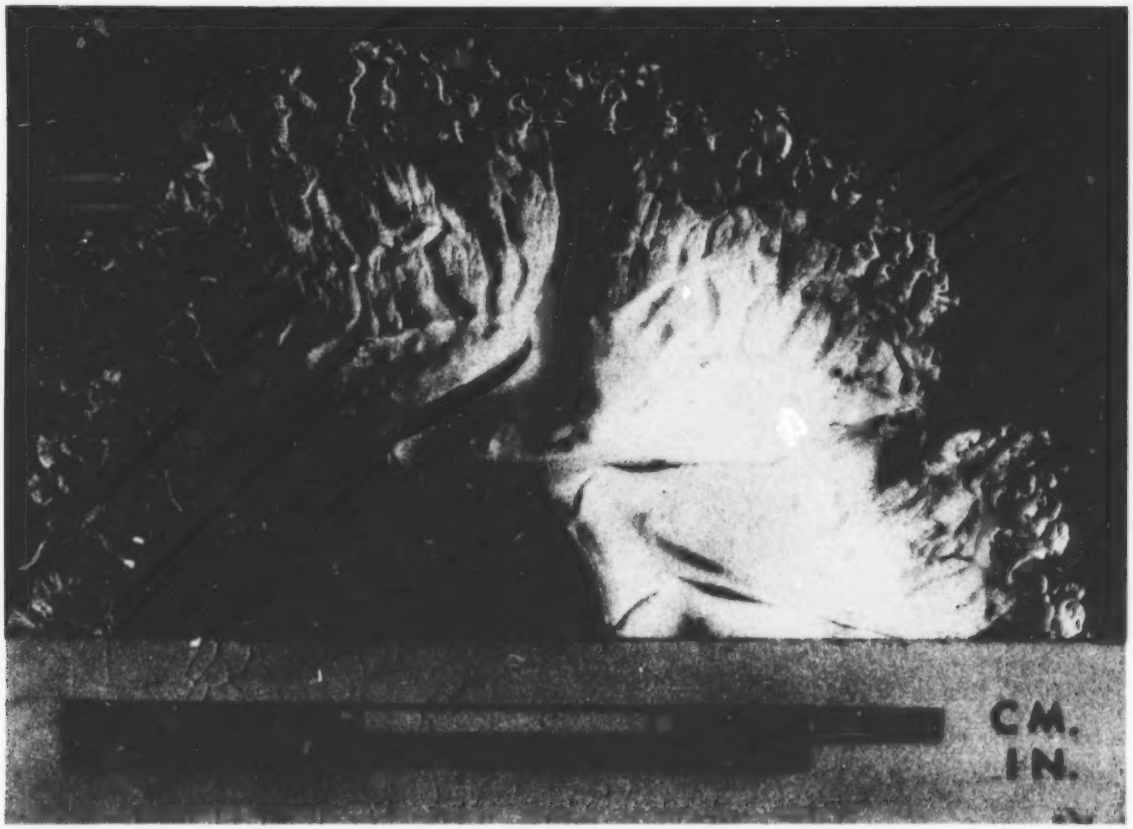


Fig. 21. S. cariosus: close-up of the bases of the parietal tubes on the specimen in Fig. 19 and 20. (Photo by R. Chan.)

Fig. 22. S. cariosus: interior surface of lateral plate of archaeological specimen 1T1C4B. The typical sponge-like texture of the parietal tubes is clearly visible. Dark growths are bryozoan colonies; their presence below the mantle line indicates the specimen was dead at capture. (Photo by R. Chan.)

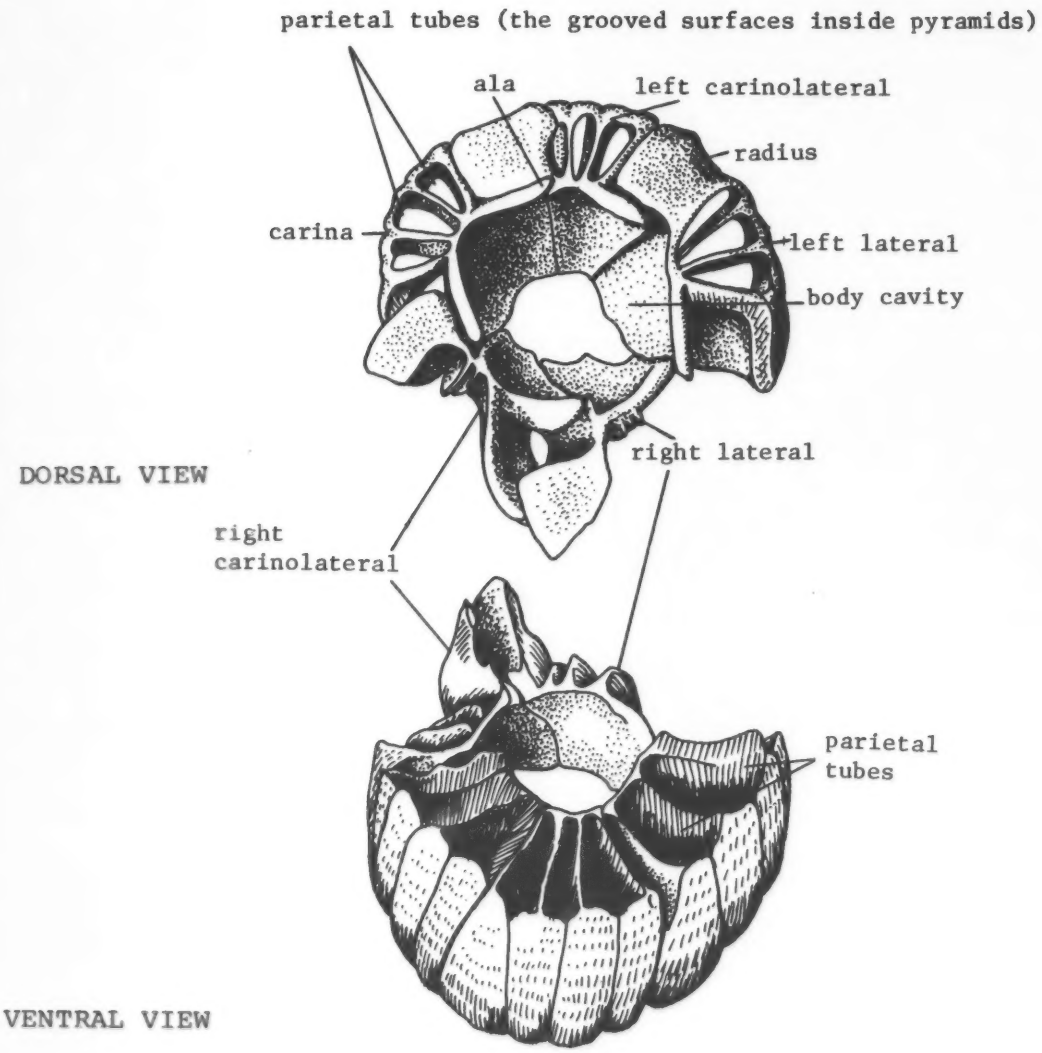


Fig. 23. Coronula reginae: diagrammatic representation of archaeological specimen 1T1C2 showing arrangement of body wall plates and their pyramidal structure. The opercular plates and rostrum are missing. (Drawing by Sally Gadd.)

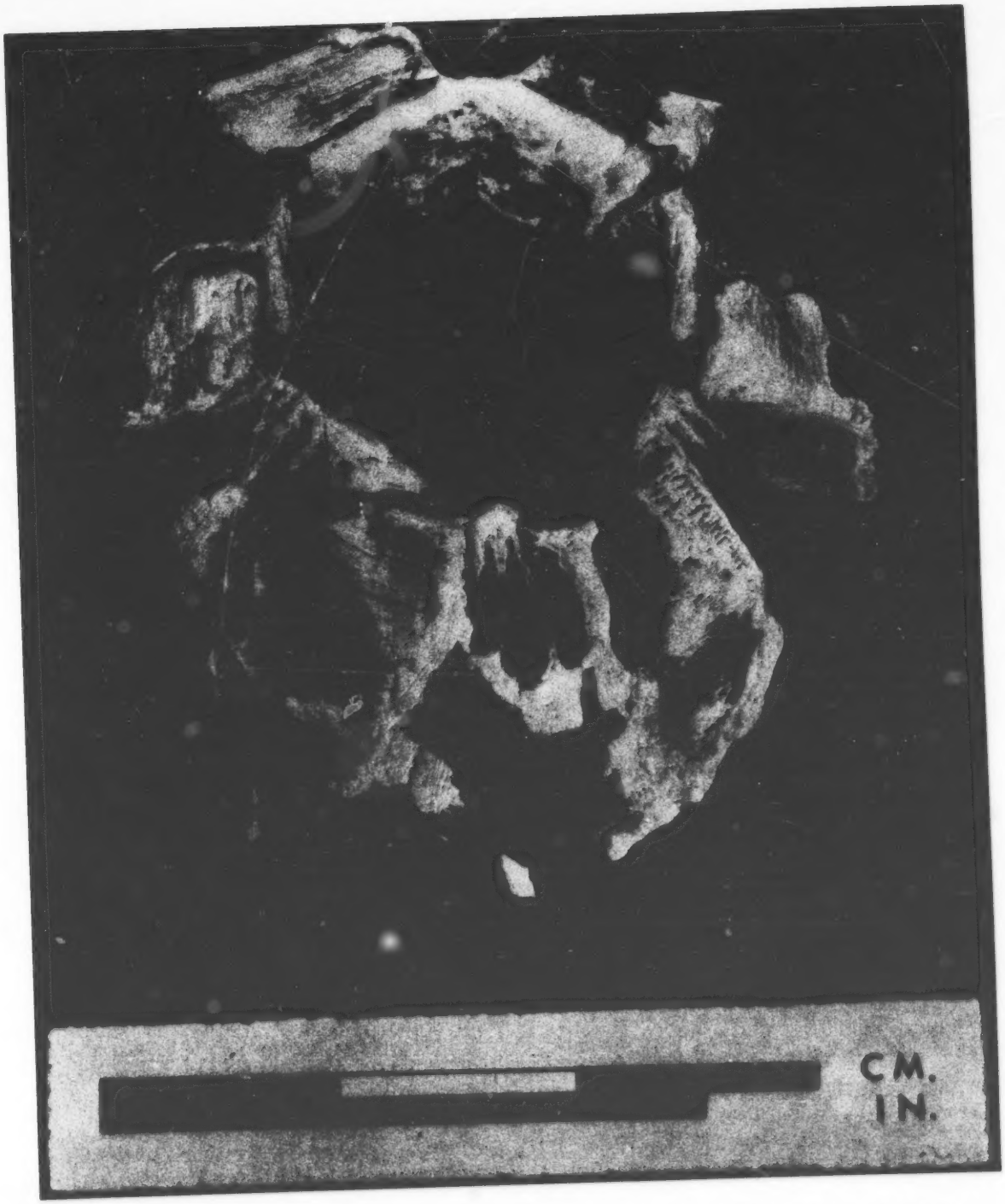


Fig. 24. C. reginae: three-quarter dorsal view of intact archaeological specimen 1T1C2 showing body cavity and the structure and sculpture of the plates. Dark areas are a commensal diatom usually associated with C. reginae. (Photo by R. Chan.)

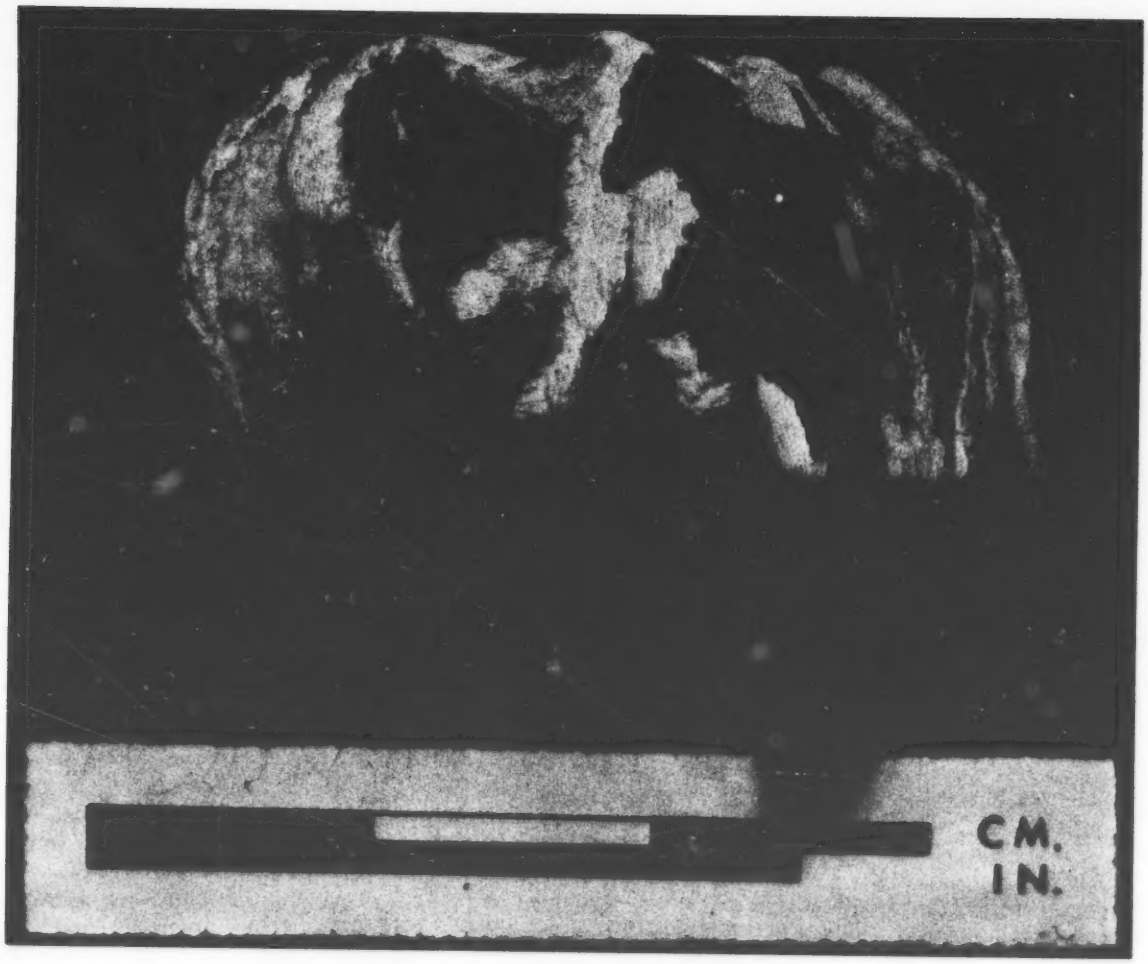


Fig. 25. C. reginae: lateral view of intact, nearly complete archaeological specimen 1T1C2. (Photo by R. Chan.)

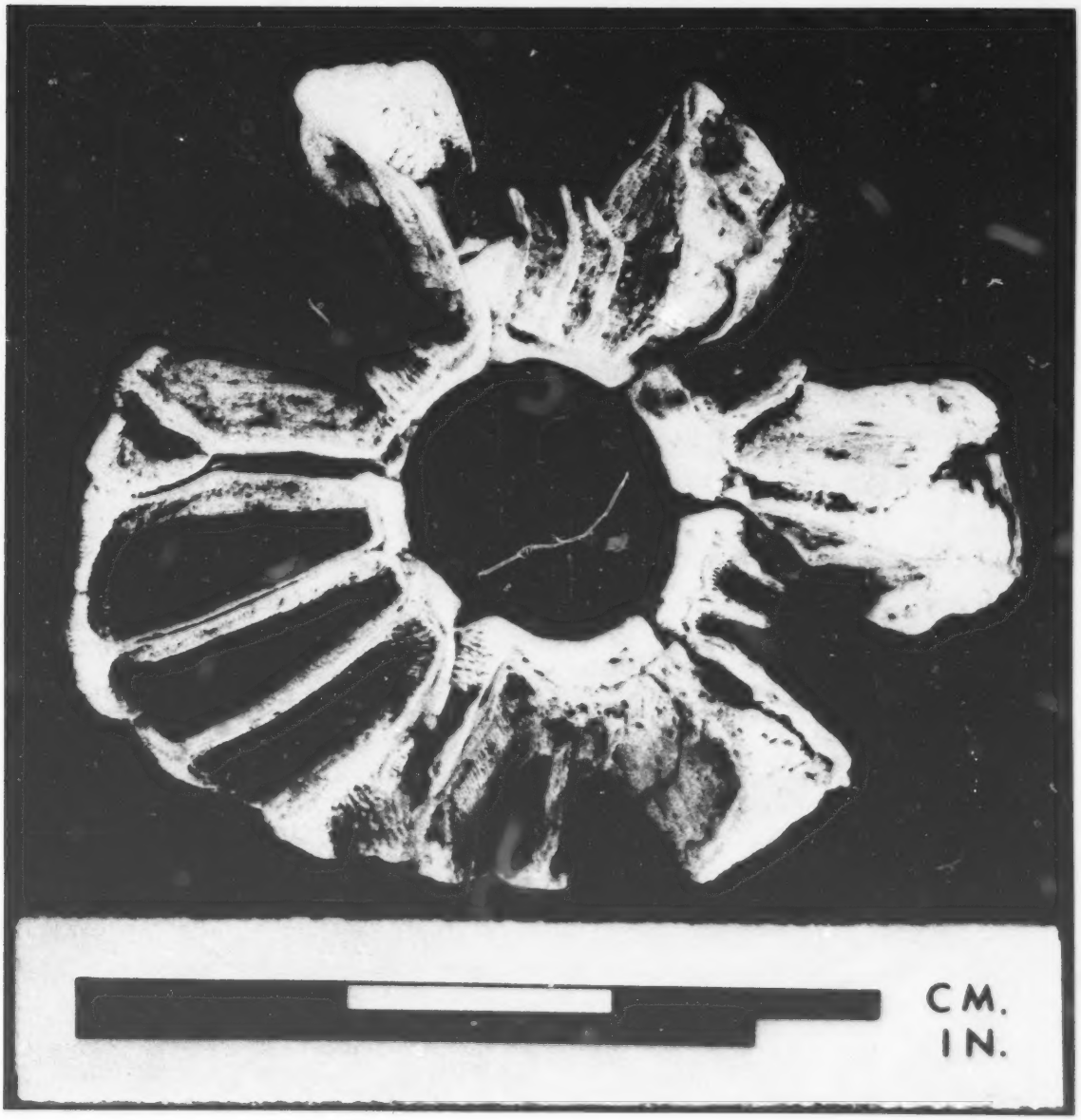


Fig. 26. C. reginae: ventral view of intact, nearly complete archaeological specimen 1T1C2 showing distinctive internal structure of the plates and diagnostic sculpture of the parietal tubes. Grooved surfaces within the triangular-shaped parietal tubes distinguish C. reginae from its sister species C. diadema. (Photo by R. Chan.)

Table 1. Remains of Barnacle Species by Stratigraphic Zones

Species	Zone	Whole Animal	Carinas	Carino-laterals	Laterals	Rostra	Bases	Scuta	Terga	Fragments	Total Pieces
B. nubilus	IV	43	54	48	137	50	22	8	1	104	467
alive at capture	III	0	0	1	6	2	2	0	0	2	13
	II	2	4	3	12	0	5	1	0	10	37
	I	0	0	0	0	0	0	0	0	0	0
B. nubilus	IV	12	20	18	62	17	12	2	0	9	152
dead at capture	III	0	3	0	10	1	3	0	0	9	26
	II	0	5	2	6	0	2	0	0	3	18
	I	0	0	0	0	0	0	0	0	0	0
S. cariosus	IV	2	54	28	147	59	-	2	0	28	320
alive at capture	III	0	21	7	45	21	-	0	0	42	136
	II	6	19	5	54	29	-	0	0	31	144
	I	0	0	0	0	0	-	0	0	0	0
S. cariosus	IV	0	4	0	12	2	-	0	0	1	19
dead at capture	III	0	2	0	11	5	-	0	0	7	25
	II	0	5	0	17	3	-	0	0	3	28
	I	0	1	1	1	2	-	0	0	0	5
C. reginae	IV	1	4	1	10	2	0	0	0	4	22
	III	0	0	0	0	0	0	0	0	0	0
	II	0	0	0	0	1	0	0	0	0	1
	I	0	0	0	0	0	0	0	0	0	0
B. glandulus	IV	0	0	0	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0	0	0	0
	II	0	0	0	1	2	0	0	0	0	3
	I	0	0	0	0	0	0	0	0	0	0
Unidentified	IV	1	1	0	7	2	2	0	0	6	19
species	III	0	0	0	1	0	0	0	0	9	10
alive at capture	II	0	0	0	4	2	0	0	0	0	6
	I	0	0	0	0	0	0	0	0	0	0

Analysis

Shells of the sessile barnacles in British Columbia possess distinctive single and paired plates (Fig. 1, 18, 23), which permit estimates of numbers of individuals present and their quantity of meat according to the methods used in vertebrate faunal analysis (Grayson 1973).

The minimum number of individuals (MNI) of a barnacle species can be calculated by counting the number of whole shells and then adding to that either the count of the most abundant single plate or one-half the count of the most abundant paired plates - whichever is greater. This method ignores fragments that could not be identified with regard to plate, and therefore is reasonably sound only if unidentifiable fragments consitute an insignificant portion of the remains.

Another method of calculating the MNI is by weight. All specimens and fragments of a species are weighed and then divided by a weight indicative of the "average" individual of the species. This method accounts for all remains present, but an average individual weight truly representative of cultural selection of a species is rather arbitrary.

Both methods were applied here for comparative purposes because numbers of Yuquot epifaunal molluscs were determined by weight (Clarke and Clarke 1974), and some zooarchaeologists use the weight approach in analysing invertebrate remains.

Once the MNI is calculated, it is multiplied by a factor representing the meat weight of the individual. This is the average meat weight of a number of freshly killed animals. Such a factor is arbitrary and does not take into account cultural selection, but it does allow an estimate of the amount of meat provided by the archaeological specimens.

The mean shell weights and mean meat weights (Table 2) were calculated from fresh samples of *B. nubilus* and *S. cariosus* collected at Ten Mile Point near Victoria, B.C. The meat was removed from the specimens and weighed. The shells were cleaned of membrane, dirt, and surface growths and then continuously dried until a constant weight was attained.

Calculation of MNI and meat weights by plate counts (Table 3), in contrast to the weight approach (Table 4), yields significantly more individuals and, correspondingly, more meat. Calculation by plate count appears to be more accurate because it takes into account incomplete plates and individual size and growth differences. The plate count cannot deal with fragments unidentifiable with regard to plate, but here such numbers (Table 3) are generally insignificant. The weight approach utilizes such fragments, thereby accounting for all remains of a species. However, the weight approach makes larger animals count more than they actually should and does not fully account for fragments that can be identified with regard to plate.

As noted earlier, results for each stratigraphic zone must be compared relatively. To facilitate this comparison, the MNI and meat

weights of the two food species are given in percentages, for each approach (Tables 5, 6). In Zones II and III the ratio of B. nubilus to S. cariosus is small and relatively constant. Here, S. cariosus was clearly the more abundant species as indicated by both plate count and weight methods; it made up 80 - 90% of the total individuals of the two species by plate count (Table 5), and more than 90% by the weight method (Table 6). But, despite the very low proportion of B. nubilus individuals, this species contributed 70 - 80% of the meat by plate count (Table 5) and 20 - 55% of the meat by the less precise weight method (Table 6).

In Zone IV, however, the more abundant species changes dramatically to B. nubilus, which accounted for 60% of the individuals by plate count (Table 5) and 30% by the weight method (Table 6). Correspondingly, B. nubilus yielded an even greater proportion of meat for the two species: 97% by plate count (Table 5) and 89% by the weight method (Table 6). Reasons for this change through time will be suggested later in this paper.

The next most abundant species is the whale barnacle, C. reginae, which totalled six individuals by plate count (Table 5). One was found in Zone II, and the other five in Zone IV. Whale barnacles were not eaten (Drucker 1951: 39), but their presence in the midden would indicate utilization of their substratum, the humpback whale.

Biological and Cultural Factors

The significance of the archaeological barnacles and their temporal distribution can be understood through consideration of biological and cultural factors pertinent to each species.

Balanus nubilus Darwin, often exceeding 100 mm in diameter, is the largest barnacle found on the Pacific coast of North America. It occurs on rocks, piles, and other barnacles from the low water mark to as deep as 60 m. Balanus nubilus tends to grow in clumps of 20 or more individuals, of which often only one may be attached to a rock or other substratum (Pilsbry 1916; Cornwall 1925, 1955; Henry 1940). It frequently grows on the holdfasts of kelp and is often cast ashore attached to kelp that has broken loose in storms. Balanus nubilus is known as a food source and considered a delicacy (Cornwall 1925: 480). Those found on kelp holdfasts were roasted and eaten by Indians (Carl 1963: 116). The status of B. altissimus has already been discussed.

Most archaeological B. nubilus were smaller animals, typical of the intertidal members of this species. The largest specimens were often penetrated by borers and contained polychaete tubes and broyozoans inside the shell, indicating that the barnacles were likely dead at capture. However, these dead specimens were probably covered or surrounded by living members of their own species, forming a typical clump. The common smaller size suggests that most B. nubilus were gathered along the shore, probably during foraging for other invertebrates. This is also supported by the fact that several B. nubilus, mostly the small variety which tends to live near the low water mark, show indications of having been scraped off the substratum.

Elderly Moachat, when shown a complete specimen of B. nubilus, did not recognize it or seem to be aware of it as a food source. This response might be expected because sessil barnacles have not been

gathered for years and B. nubilus is not easily collected. Also, it has been generations since Nootkans collected kelp stalks, another substratum of B. nubilus, for manufacture of fishing lines.

Semibalanus cariosus (Pallas), which reaches a diameter of 75 mm and a height of 80 mm (Henry 1940), is the largest of the common intertidal barnacles. It is the dominant species of the intertidal zone, covering rocks from within 3 ft. of the high tide mark to 2 ft. above the lowest tide mark (Henry 1940; Cornwall 1955). The largest specimens are found in sheltered areas.

Elderly Moachat described their food barnacle as having a membranous base, and thus were aware of S. cariosus. Since it is the largest readily available species on the coast of Vancouver Island, its use is logical. The membranous base would probably make S. cariosus easier to remove from rocks than species with a calcareous base. In the experience of elderly Moachat, the barnacles were pried or knocked off rocks and cooked by boiling. Smaller, accidental species that might be attached to the large barnacles were also eaten, but no deliberate effort was made to seek these out as a food source.

The Moachat collection and traditional cooking of S. cariosus were probably the same as those recorded for the Manhousat (Ellis 1976: 20-1, 122), who lived on Sidney Inlet about 40 km southeast of Yuquot. The barnacles were considered to be at their best in the summer, and were dislodged from rocks by means of sticks or heavy knives. They were cooked by steaming in a pit. A fire was lit in a pit lined with hard beach pebbles. When the fire burned down, the hotter ashes were removed, and the barnacles were stacked on the hot stones. Then, the pit was covered with an old cedarbark mat, and a small amount of water was added to the pit, thereby quickly steaming the barnacles.

This method of cooking would account for the large numbers of archaeological S. cariosus and B. nubilus with wood ashes sticking to them (Table 7). The wood ashes suggest that the barnacles were cooked in their shells.

The archaeological distribution of the two food species through time might also be accounted for by Manhousat foraging practices. In Zones II and III (ca. 200 B.C. - A.D. 1790), S. cariosus was the preferred species. However, in Zone IV (A.D. 1790 to 1966) preference changed markedly to B. nubilus. Unusually low tides and increased hours of daylight greatly facilitated the collection of marine invertebrates (Ellis 1976: 118-20); the extremely low spring tides no doubt made B. nubilus more accessible. During the postcontact period represented by Zone IV, the traditional "summer villages" such as Yuquot came to be occupied more densely and year-round as traders established stores in the mid and late 19th century. The increased B. nubilus in Zone IV may reflect a more intensified occupation of Yuquot during the spring.

Balanus glandulus Darwin and B. crenatus (Brugière) are commonly associated with S. cariosus. Both can be abundant, but they are much smaller species than S. cariosus; B. glandulus attains a diameter of about 20 mm, and B. crenatus a maximum diameter of 28 mm (Henry 1940). The solitary specimens of these species were probably collected incidentally when growing on either S. cariosus or B. nubilus.

Coronula reginae Darwin lives embedded almost exclusively in the flesh of the lower lips, throat, and flippers of the humpback whale, Megaptera nodosa (Bonnaterre). However, an occurrence on the sperm whale has been recorded (Cornwall 1955).

The humpback was one of the two major whale species hunted by the Nootka (Drucker 1951: 48). Beached whales and dead whales cast ashore were also used for food. The archaeological C. reginae were probably brought embedded in the whale flesh to the midden. They would not be worth the effort of removing them. The attachment of C. reginae almost exclusively to the humpback whale makes this barnacle a valuable archaeological indicator of humpback utilization. The distribution of C. reginae in the archaeological contexts at Yuquot indirectly indicates humpback utilization since at least ca. 200 B.C.

Notable Absent Species

The archaeological presence of certain barnacles and our knowledge of Nootkan culture suggest that remains of other barnacle species should or could be present in the Yuquot midden. The physical composition of some species, such as goose barnacles (Family Lepadidae), would likely leave no remains archaeologically. In other cases the life cycle and ecology of certain species and their substrata may have precluded capture by Nootkans. Nevertheless, discussion of such species provides a more comprehensive picture of barnacles as a food source and as potential indicators of subsistence resources.

Nootkan peoples of Alberni Inlet still collect goose barnacles (A. McMillan, personal communication, June 1976). These must be Mitella polymerus (Sowerby), the only pedunculate barnacle found above the low tide level in British Columbia, and whose peduncle was used for food (Cornwall 1955: 40-41). This species was also eaten by the Manhousat Nootka, who steamed the barnacles in fire pits, removed the peduncle, and ate the insides still attached to the capitulum (Ellis 1976: 35-36). The Manhousat method of cooking and dismembering is probably typical of most Nootkan groups. Mitella polymerus, when available, was likely consumed throughout the Nootkan culture area.

Further archaeology at Yuquot, or at other large Nootkan middens, may reveal remains of other species absent from our sample. All are potential species-specific indicators of whale utilization.

Cryptolepas rachianecti Dall, which embeds itself almost completely in the head and undersides of flippers and flukes of the California grey whale, Eschrichtius glaucus (Cope) (Cornwall 1955: 49), should theoretically be present in the archaeological remains, because this cetacean was hunted by the Nootka (Drucker 1951: 48).

No remains were found of Coronula diadema (Linnaeus), a sessile barnacle abundant on the humpback whale and often occurring with C. reginae (Cornwall 1955: 54). However, whaling in the Moachat subsistence cycle took place mostly in the spring and summer (Dewhirst 1977). The C. diadema are very small in early summer, and many are lost by the end of summer (Cornwall 1955: 52).

Conchoderma auritum (Linnaeus), a pedunculate species often attached to shells of Coronula on the humpback whale (Cornwall 1955: 58), was not present in the archaeological sample.

Table 2. Grams of Meat and Constantly Dried Shells from Fresh Samples

Species	Range	Mean	SD	No.
B. nubilus				
Meat wt.	2.00 - 123.40	65.250	32.7882	33
Constantly dried shell wt.	2.80 - 306.00	141.776	93.0615	33
S. cariosus				
Meat wt.	0.20 - 7.80	3.440	5.05226	32
Constantly dried shell wt.	0.45 - 55.85	15.733	12.93480	32

Table 3. Estimation of Minimum Number of Individuals (MNI) and Meat Weights by Plate Count

Species	Zone	Individuals	Meat (Grams)
B. nubilus alive at capture	IV	112	7308.00
	III	3	195.75
	II	8	522.00
	I	0	0.0
B. nubilus dead at capture	IV	43	
	III	5	
	II	5	
	I	0	
S. cariosus alive at capture	IV	76	261.44
	III	23	79.12
	II	35	120.40
	I	0	0.0
S. cariosus dead at capture	IV	6	
	III	6	
	II	9	
	I	2	
C. reginae	IV	5	
	III	0	
	II	1	
	I	0	
B. glandulus	IV	0	
	III	0	
	II	2	
	I	0	
Unidentified species	IV	5	
	III	1	
	II	2	
	I	0	

Table 4. Estimation of MNI and Their Meat Weights by Average Weight

Species	Zone	Plates (Grams)	Fragments (Grams)	Total Grams	Indiv.	Meat (Grams)
B. nubilus alive at capture	IV	570.16	45.33	615.49	4.34	283.38
	III	21.07	0.51	21.58	0.15	9.99
	II	61.55	3.93	65.48	0.46	30.13
	I	0.0	0.0	0.0	0.0	0.0
B. nubilus dead at capture	IV	763.09	25.47	788.56		
	III	120.45	30.98	151.43		
	II	98.07	9.22	107.29		
	I	0.0	0.0	0.0		
S. cariosus alive at capture	IV	158.49	7.15	165.64	10.33	36.22
	III	145.75	37.23	182.98	11.63	40.01
	II	98.07	9.22	107.29	6.82	23.46
	I	0.0	0.0	0.0	0.0	0.0
S. cariosus dead at capture	IV	57.04	1.20	58.24		
	III	41.44	6.03	47.47		
	II	58.51	2.67	61.18		
	I	2.34	0.0	2.34		
C. reginae	IV	23.71	1.06	24.77		
	III	0.0	0.0	0.0		
	II	1.79	0.0	1.79		
	I	0.0	0.0	0.0		
B. glandulus	IV	0.0	0.0	0.0		
	III	0.0	0.0	0.0		
	II	0.15	0.0	0.15		
	I	0.0	0.0	0.0		
Unidentified species	IV	3.25	1.42	4.67		
	III	4.01	12.38	16.39		
	II	0.63	0.0	0.63		
	I	0.0	0.0	0.0		

Table 5. Comparison by Percentage of MNI and Meat of Live B. nubilus and S. cariosus (from Plate Count)

Zone	MNI of B. nubilus & S. cariosus (100%)	% Individuals		Total Grams Meat (100%)	% Grams Meat	
		B. nubilus	S. cariosus		B. nubilus	S. cariosus
IV	188	59.57	40.43	7569.44	96.55	3.45
III	26	11.54	88.46	274.87	71.22	28.78
II	43	18.60	81.40	642.40	81.26	18.74
I	-	-	-	-	-	-

Table 6. Comparison by Percentage of MNI and Meat of *B. nubilus* and *S. cariosus* (from Weight Method)

Zone	MNI of *B. nubilus* & *S. cariosus* (100%)	% Individuals		Total Grams Meat (100%)	% Grams Meat	
		B. nubilus	*S. cariosus*		*B. nubilus*	*S. cariosus*
IV	14.87	29.20	70.80	319.60	88.67	11.33
III	11.78	1.29	98.71	49.93	19.87	80.13
II	7.28	6.33	93.67	53.59	56.22	43.78
I	-	-	-	-	-	-

Table 7. Plates and Fragments With and Without Ashes

Species	Zone	Total Pieces	Pieces with Ash	Pieces without Ash
B. nubilus alive at capture	IV	467	138	329
	III	13	1	12
	II	37	0	37
	I	0	0	0
B. nubilus dead at capture	IV	152	21	131
	III	26	0	26
	II	18	0	18
	I	0	0	0
S. cariosus alive at capture	IV	320	75	245
	III	136	22	114
	II	144	16	128
	I	0	0	0
S. cariosus dead at capture	IV	19	6	13
	III	25	5	20
	II	28	1	27
	I	5	0	5
C. reginae	IV	22	5	17
	III	0	0	0
	II	1	0	1
	I	0	0	0
B. glandulus	IV	0	0	0
	III	0	0	0
	II	3	0	3
	I	0	0	0
Unidentified species	IV	19	5	14
	III	10	0	10
	II	6	0	6
	I	0	0	0

Summary

We have reviewed the methods of identifying barnacle remains by "figures in the shell," and applied them to a large archaeological sample spanning 4000 years. Two species previously little known both archaeologically and ethnographically were found to be the major species. Both were used as food, as suggested by wood ashes adhering to the shells from cooking. Prehistorically S. cariosus appears to have been more common, but in the historic period B. nubilus is more abundant. This change in ratios between these species may result from changes in native subsistence and residence patterns in the historic period. The different ratios between the two species may also characterize respective prehistoric and historic period deposits in Nootkan middens; however, further zooarchaeological analyses are required to confirm this. A third food species known ethnographically, the goose barnacle, M. polymerus, left no archaeological traces.

Of special interest is the whale barnacle, C. reginae, which indirectly indicates humpback whale utilization at Yuquot since ca. 200 B.C. Other species-specific whale barnacles should theoretically have been present in the archaeological sample, but were not encountered. Such barnacle species offer considerable potential for interpretation of Nootkan culture history.

References Cited

Boas, Franz. 1921. Ethnology of the Kwakiutl. Bureau of American Ethnology, Thirty-fifth Annual Report, (1913-1914), Part 1, pp. 43-1481. Washington.

Carl, G. Clifford. 1963. Guide to Marine Life of British Columbia. British Columbia Provincial Museum Handbook No. 21. British Columbia Provincial Museum, Victoria.

Clarke, Louise R. and Arthur H. Clarke. 1974. Zooarchaeological Analysis of Mollusc Remains from Yuquot, B.C. Manuscript on file, National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, The Yuquot Project, Vol. 2.)

Cornwall, Ira E. 1925. A Review of the Cirripedia of the Coast of British Columbia. Contributions to Canadian Biology, New Series, Vol. 2, Pt. 2, pp. 471-502.

---. 1936. On the Nervous System of Four British Columbian Barnacles (One New Species). Journal of the Biological Board of Canada, Vol. 1, No. 6, pp. 469-75.

---. 1955. The Barnacles of British Columbia. British Columbia Provincial Museum Handbook No. 7. British Columbia Provincial Museum, Victoria.

---. 1956. Identifying Fossil and Recent Barnacles by the Figures in the Shell. Journal of Paleontology, Vol. 30, No. 3, pp. 646-51.

---. 1958. Identifying Recent and Fossil Barnacles. Canadian Journal of Zoology, Vol. 36, No. 1, pp. 79-84.

---. 1959. More Shell Figures and Notes on Barnacles. Canadian Journal of Zoology, Vol. 37, No. 4, pp. 401-6.

Dewhirst, John. 1977. The Origins of Nootkan Whaling: A Definition of Northern and Central Nootkan Ecological Orientation for the Past Four Millenia. Paper presented at the Canadian Archaeological Association, Tenth Annual Meeting, 5-8 May 1977, Ottawa.

---. 1980. The Indigenous Archaeology of Yuquot, A Nootkan Outside Village. National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, No. 39, The Yuquot Project, Vol. 1.)

Drake, Robert J. 1963. Molluscs from Pacific Northwest Archaeological Sites, 2. Washington: 45-CA-30, a Coastal Shellmidden in the Ozette Area. Bulletin of the Southern California Academy of Sciences, Vol. 62, Pt. 2, pp. 101-8.

Drucker, Philip. 1951. The Northern and Central Nootkan Tribes. Bureau of American Ethnology Bulletin 144. Smithsonian Institution, Washington.

Ellis, David W. 1976. The Knowledge and Usage of Marine Invertebrates, Insects, Reptiles, and Amphibians by the Manhousat People of the West Coast of Vancouver Island. Manuscript on file, British Columbia Indian Language Project, Victoria, B.C.

Grayson, Donald K. 1973. On the Methodology of Faunal Analysis. American Antiquity, Vol. 39, No. 4, pp. 432-39.

Henry, Dora P. 1940. The Cirripedia of Puget Sound with Key to the Species. University of Washington Publications in Oceanography, Vol. 4, No. 1, pp. 1-48.

---. 1942. Studies on the Sessile Cirripedia of the Pacific Coast of North America. University of Washington Publications in Oceanography, Vol. 4, No. 3, pp. 95-134.

Newman, William A. and Arnold Ross. 1976. Revision of the Balanomorph Barnacles, Including a Catalogue of the Species. San Diego Society of Natural History Memoirs, Memoir 9.

Pilsbry, H.A. 1916. The Sessile Barnacles (Cirripedia) Contained in the Collections of the U.S. National Museum, Including a Monograph of the American Species. U.S. National Museum Bulletin 93, Washington.

Avian Fauna from the Yuquot Excavation

Nancy M. McAllister

105 Abstract
106 Acknowledgements
107 Introduction
116 Methods
119 Species Found in Large Numbers
119 Beach Scavengers
119 Bald Eagle (Haliaeetus leucocephalus)
120 Northwestern Crow (Corvus caurinus)
122 Raven (C. corax)
122 Large Gulls (Larus sp.)
123 Mew Gull (Larus canus) (Some Kittiwake)
124 Black-legged Kittiwake (Rissa tridactyla)
124 Diving Sea Birds
124 Common Murre (Uria aalge)
125 Marbled Murrelet (Brachyramphus marmoratus)
125 Cormorants
126 Double-crested Cormorant (Phalacrocorax auritus)
126 Brandt's Cormorant (P. penicillatus)
126 Pelagic Cormorant (P. pelagicus)
127 Common Loon (Gavia immer)
127 Arctic Loon (G. arctica)
127 Red-necked Grebe (Podiceps grisegena)
128 Western Grebe (Aechmophorus occidentalis)
128 Surf Scoter (Melanitta perspicillata) and Common Scoter (Oidemia nigra)
129 White-winged Scoter (M. deglandi)
129 American Merganser (Mergus merganser)
129 Geese
129 Canada Goose (Branta canadensis)
130 Snow Goose (Chen caerulescens)
131 Black Brant (B. bernicla)
131 Sea Surface Scavengers
131 Short-tailed Albatross (Diomedea albatrus)
137 Shearwater (Puffinus sp.)
138 Major Food Species
140 Species Found in Small Numbers (Fewer than 22 Bones)
140 Red-throated Loon (G. stellata)
140 Grebes
140 Northern Fulmar (Fulmarus glacialis)

143 Fork-tailed Petrel (Oceanodroma furcata)
143 Brown Pelican (Pelecanus occidentalis)
143 Great Blue Heron (Ardea herodias)
143 Whistling Swan (Olor columbianus)
144 White-fronted Goose (Anser albifrons)
144 Mallard (Anas platyrhynchos)
144 Pintail (A. acuta)
144 Green-winged Teal (A. carolinensis)
144 American Widgeon (Mareca americana)
145 Scaup (Aythya sp., Probably Greater Scaup, A. marila)
145 Goldeneye (Bucephala sp., Probably Barrow's Goldeneye, B. islandica)
145 Bufflehead (B. albeola)
145 Old Squaw (Clangula hyemalis)
145 Peregrine Falcon (Falco peregrinus)
146 Sparrow Hawk (F. sparverius)
146 Ruffed Grouse (Bonasa umbellus)
147 Sora (Porzana carolina)
147 Shore Birds
148 Bonaparte's Gull (L. philadelphia)
148 Pigeon Guillemot (Cepphus columba)
148 Tufted Puffin (Lunda cirrhata)
148 Rhinoceros Auklet (Cerorhinca monocerata)
148 Cassin's Auklet (Ptychoramphus aleuticus)
149 Owls
149 Belted Kingfisher (Megaceryle alcyon)
150 Woodpeckers
150 Passerines
151 Horned Lark (Eremophila alpestris)
151 Fox Sparrow (Passerella iliaca)
151 Robin (Turdus migratorius)
151 Red-winged Blackbird (Agelaius phoeniceus)
153 Discussion - Species in Small Numbers
156 Missing Birds
158 Weight of Avian Bone
159 Unidentified Fragments
162 Methods of Capture and Preparation
165 Grams of Food
168 Anterior Versus Posterior Bones
169 Seasonality
171 Marine Nature of the Fauna
172 Conclusions
173 References Cited

Abstract

We identified 5966 bones and 67 species of birds. Of these, 23 species were found in more than 22 bones and were major food species. All available large- and medium-sized beach and sea birds were taken. Almost no use was made of forest birds. All were found throughout the 4000-year period of occupation of the site. The beach scavengers, Bald Eagle, Northwestern Crow, and Raven, and the diving sea birds, the loons and grebes, were found in moderate numbers. Gulls, cormorants, murres, diving ducks, geese, and Short-tailed Albatross were the species most frequently used. There is a sharp increase in the use of geese during the historic period. The large number (nearly 2000) of Short-tailed Albatross bones is unique to this midden. They constituted summer avian food while ducks, geese, and diving sea birds were not available in the summer and were taken during migrations and possibly during the winter. Beach scavengers and gulls were available year-round.

Submitted for publication 1979, by Nancy M. McAllister, Department of Biology, University of Ottawa, Ottawa.

Acknowledgements

I thank Dr. Earl Godfrey and Dr. Henri Ouellet for permission to use the skeleton collection at the National Museum of Natural Sciences, National Museums of Canada; Anne M. Rick for use of the zooarchaeology collection of the same museum; Dr. Howard Savage for use of the Royal Ontario Museum collections and for identification of some fragments found with the mammal bones; and Dr. Pierce Brodkorb for use of his collection at the University of Florida to identify the final small bits and to check the species identification of the albatross. Dr. W. Folan directed the early stages of the Yuquot faunal analysis, and Mr. John Dewhirst continued this work and provided the archaeological contexts for the analysis. John Dewhirst and Anne M. Rick kindly read and criticized the manuscript.

Introduction

Yuquot is a Moachat Nootkan village on the west coast of Vancouver Island, British Columbia (49° 35' 36" N, 126° 37' 16" W). The ethnohistory of this Indian tribe was recorded for the historic period (Drucker 1951), but little was known of the prehistory of any of the tribes of this area. In 1966 the National Historic Sites and Parks Branch of Parks Canada carried out a meticulous excavation of the huge shell midden on which the village still stands. Preliminary reports on the excavation have already been made (Folan and Dewhirst 1970; Dewhirst 1977, 1978).

The midden consists of a long rise parallel to the ocean beach, with the present houses perched on top. The excavation was a narrow cross section of the middle of the midden. Thirty-five-foot grid squares were excavated in a series of numbered layers 6 in. thick, to a maximum depth of 18 ft. Four zones were recognizable on the basis of matrix characteristics, artifacts, and radiocarbon dates:

Zone IV	A.D. 1789 - 1966
Zone III	A.D. 800 - 1789
Zone II	1000 B.C. - A.D. 800
Zone I	pre 2300 B.C. - 1000 B.C.

This dating established Yuquot as one of the oldest continuously occupied settlements in North America.

All bone was saved and can be related directly to the archaeological proveniences. This is one of the only middens where a quantitative analysis of dated faunal remains can be made, and where the faunal remains can be related to the artifacts. The avian remains collected consist of 5966 identified bones and 9078 unidentifiable avian fragments. Identification was attempted for all bones regardless of size or condition, resulting in a complete list of species within the limits of the excavation (Fig. 1-8).

A total of 67 species were identified. Within this number are three groups that could not be taken beyond genus, bringing the probable total to about 70 species. Of these, 44 species were found in very small numbers, fewer than 22 bones. These are discussed separately from the remaining 23 species which constitute the major food animals. The major food groups are discussed in order of ecological position: birds of the beach, birds of beach and sea surface, diving sea birds, diving ducks, geese, and offshore birds. Finally the origin of fragments, the weight of avian bone, methods of capture and preparation, weight of edible meat, seasonal availability, and the marine nature of the fauna are discussed.

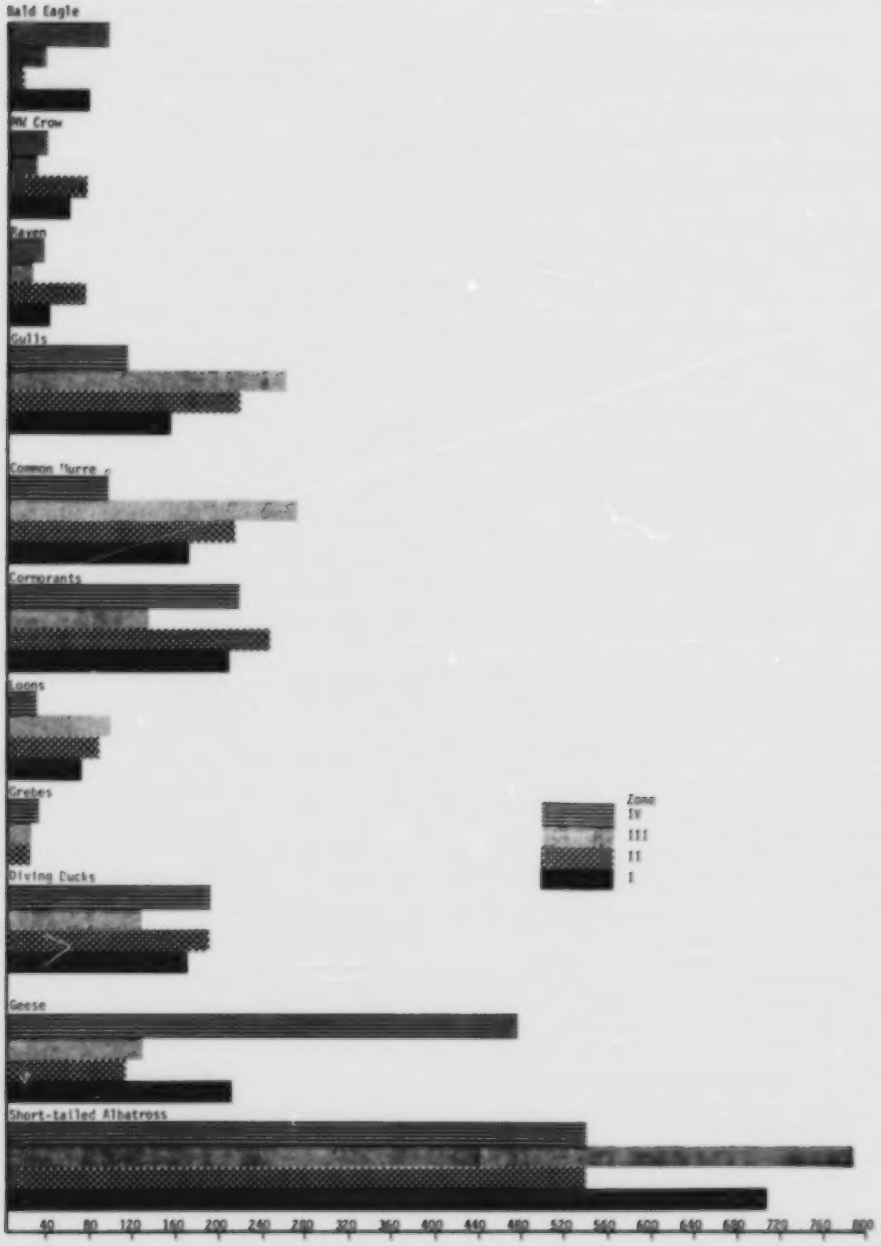


Fig. 1. Total numbers of bones in each zone. (Zone key is for Fig. 1-8.)

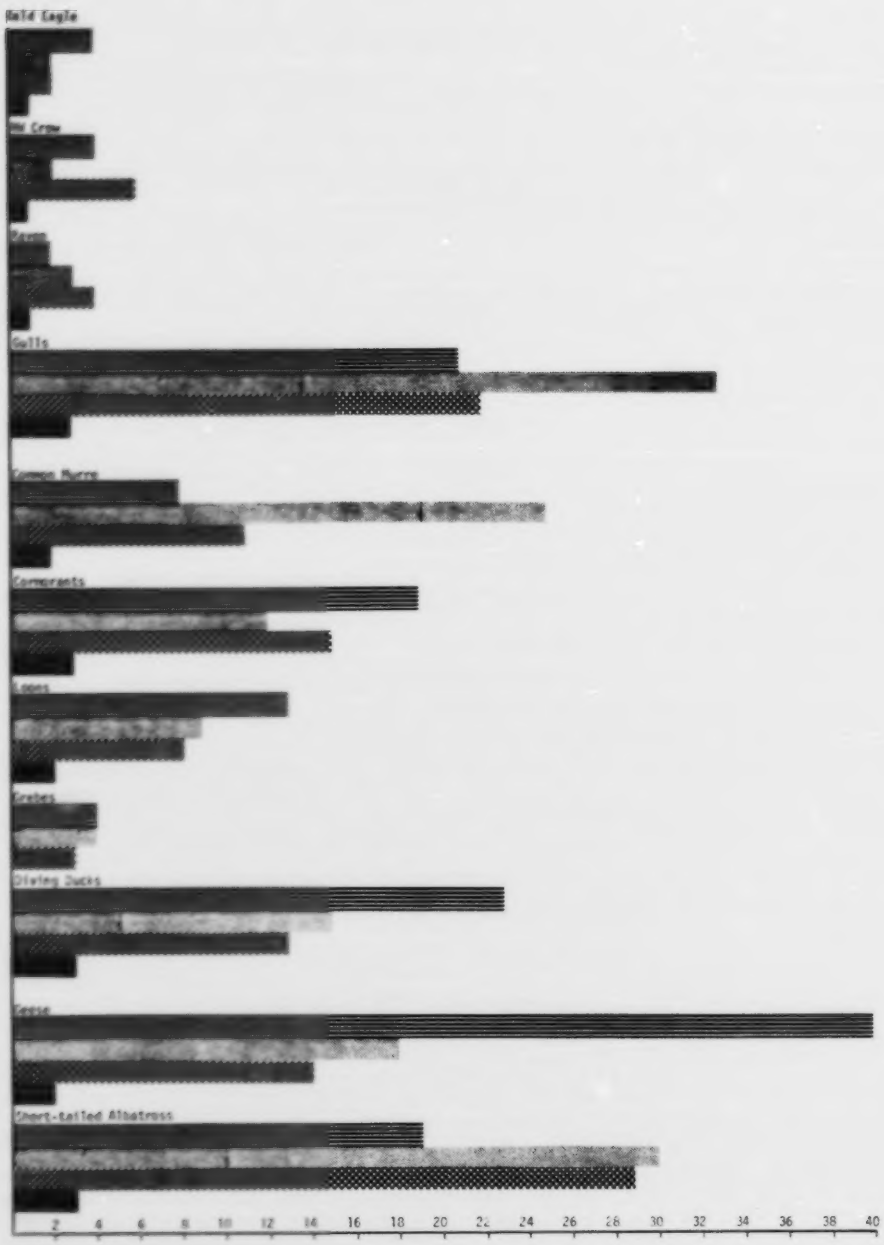


Fig. 2. Total minimum numbers of individuals in each zone.

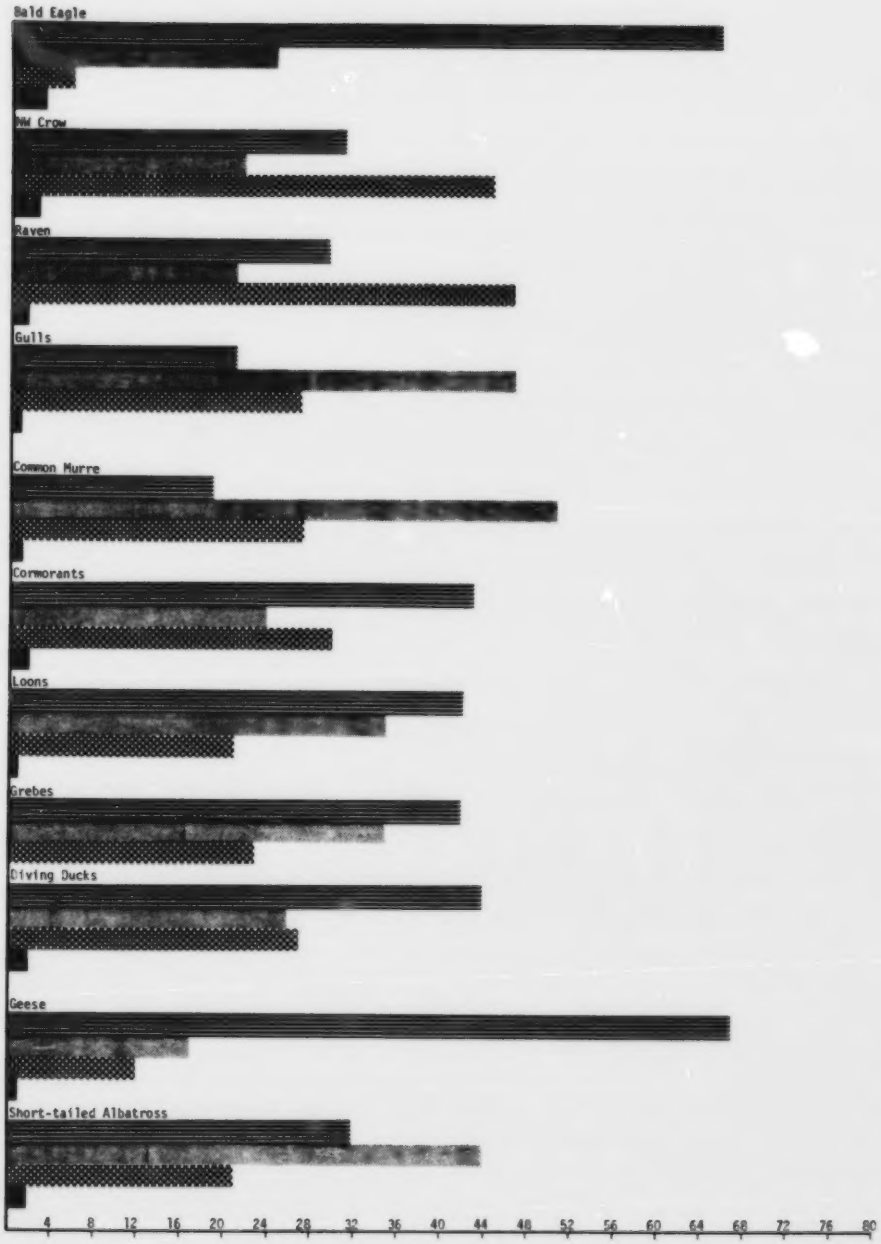


Fig. 3. Per cent of bones of each species in each zone.

Fig. 4. Per cent of minimum numbers of individuals of each species in each zone.

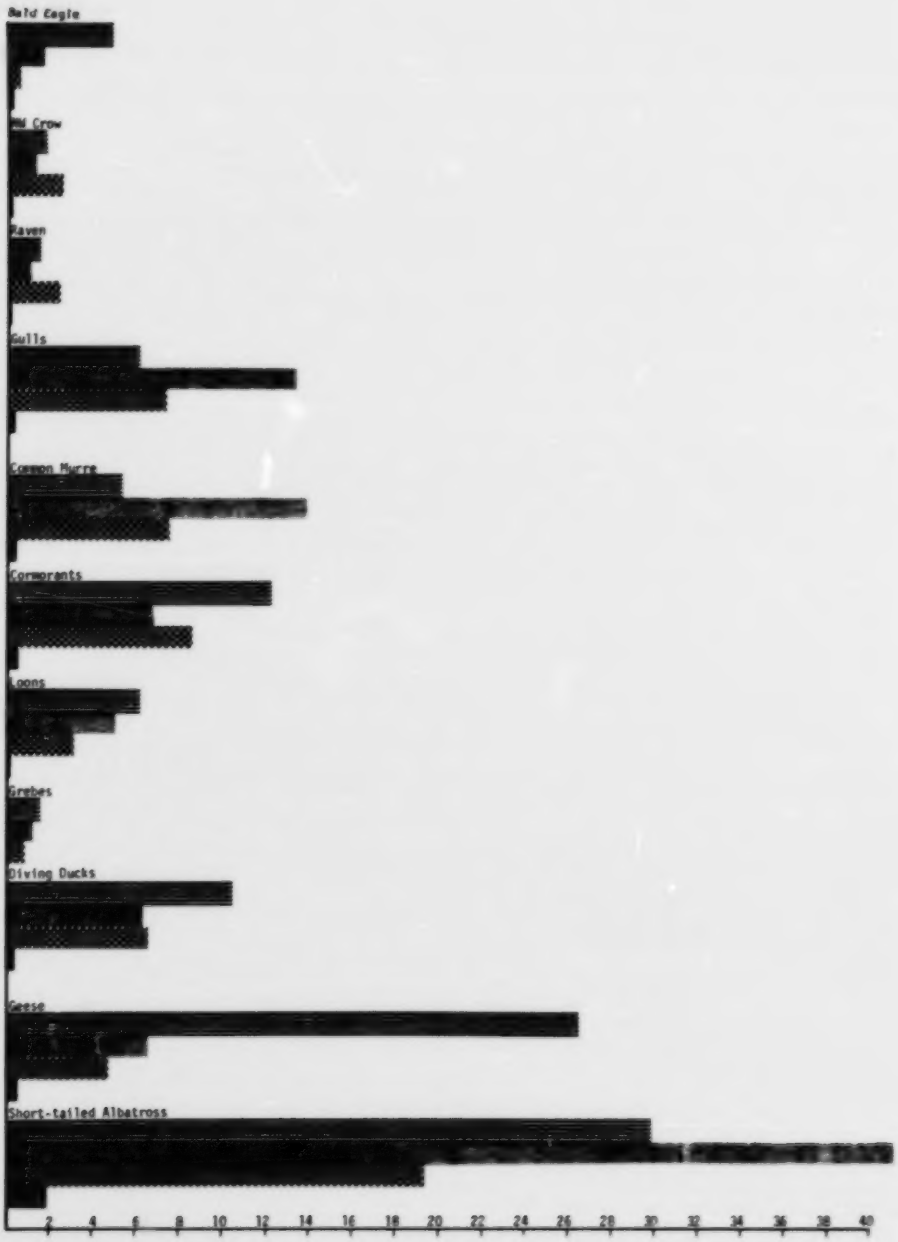


Fig. 5. Per cent of bones of each species in zone total.

Fig. 6. Per cent of minimum numbers of individuals of each species in zone total.

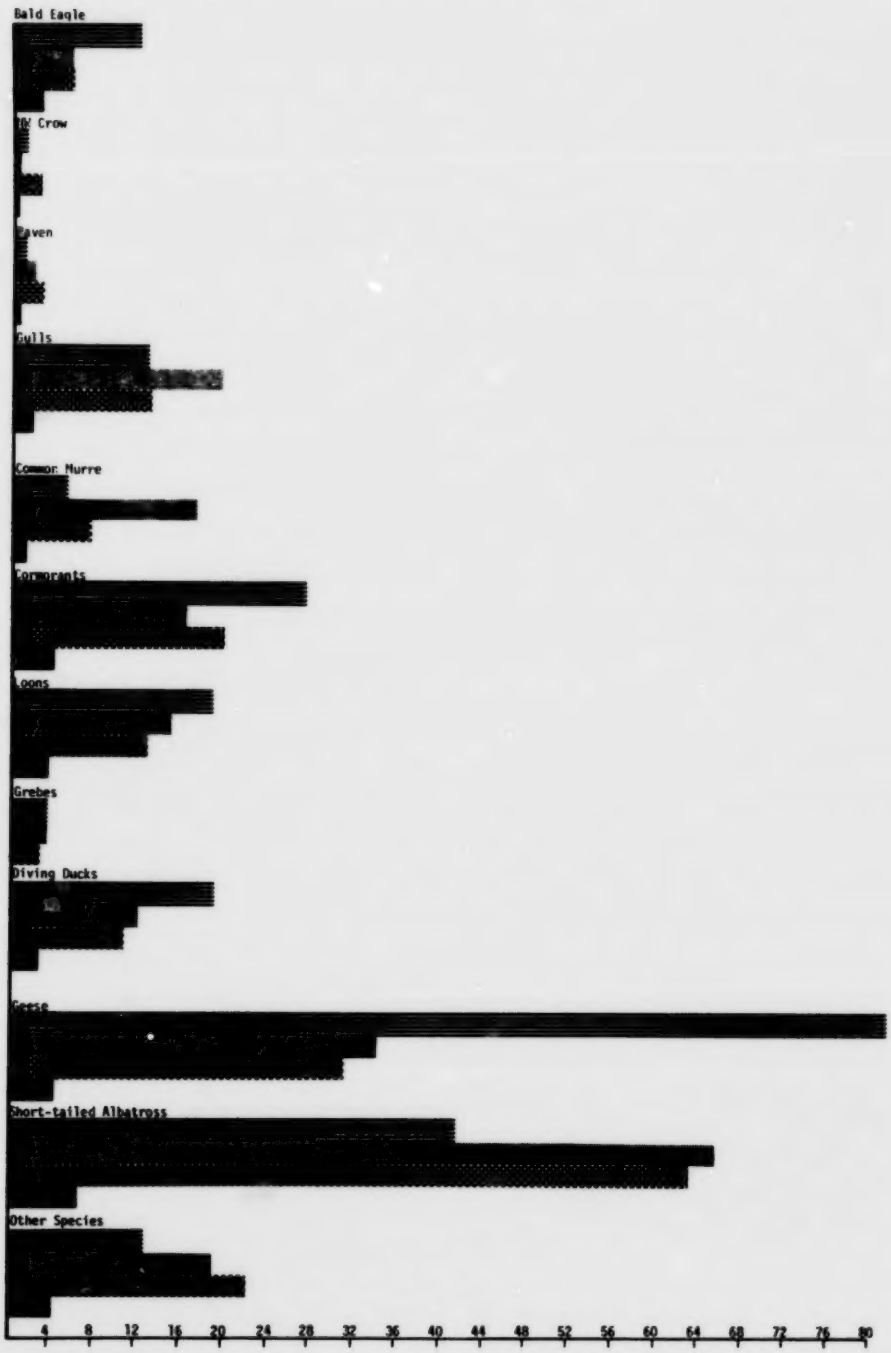


Fig. 7. Total kilograms of meat per zone.

Fig. 8. Kilograms of meat as per cent of zone total.

Methods

The avian material was sorted from the mammal bones by emptying each bag separately into a sorting tray. The mammal bones were returned first to their original bags, and then the generally smaller avian material was put into new, small paper bags identified with the lot number and the wash tag number. A numbered section of the wash tag went into the bag with the bones. (For a discussion of the use of laundry tags as control identification of lot numbers see Aish et al. 1968: 504.) The contents of each avian bag were weighed and the weights recorded on a stylized grid of the excavation with lot number and wash tag number. The unidentifiable fragments (fragments of shafts of long bones, flat pieces from sterna, and sacrum fragments) were counted and returned to the bags. Fragments were recorded as being from very large (albatross, eagle, Canada Goose), large (Common Loon, cormorant, geese, heron), medium (ducks, crows, gulls, large alcids), small (small loons, grebes, small ducks), and very small (passerines, woodpeckers, petrels, and shore birds).

Identifiable bones were numbered individually in India ink with lot number and wash tag number. The numbers remained clear without laquer covering. The numbered bones were sorted by element and all bones of one element boxed together. All the bones of one element were arranged on a large table and sorted first by size and then working each group finer and finer until each pile contained only bones virtually identical in size and shape. In the process of comparison the bones were handled in pairs or small groups, using not only key characters but the configuration of the articular end of the bone throughout a 180° rotation. Length of the intact bone and thickness, texture, and colour were occasionally useful. The final number of piles of each element ranged from 40 to 50 plus a dozen or so small and very small bones which were one of a kind. With this type of sorting consistent divisions can be made between groups of bones and separations as fine as age, sex, and subspecies classes can sometimes be made. The sorted bones were then stored in partitioned boxes with related "species" in the same box.

Identifications were made at the National Museum of Natural Sciences, National Museums of Canada, Ottawa, using both the ornithology collections and the zooarchaeology collection. Where the museum collections were inadequate, bones were taken to the Royal Ontario Museum and to Pierce Brodkorb's collection at the University of Florida. Some whole skeletons were borrowed from the Royal Ontario Museum. Dr. Howard Savage identified a few bones that had been missed in the first sorting from the mammal bones and that were subsequently returned. Identification was done family by family. The humerus was one of the most frequently occurring bones and the easiest to identify, so the group of Yuquot bones matching the museum humerus was picked out first. Then the other boxes were searched for the other elements of the family. Within the family, bone differences are often subtle and size is often the only clue to identification. Where there are only a few species of

the family present and they are sharply different in size, clear separations can be made. But in other cases there are overlaps in size in certain elements. In a few cases such as the gulls, there are several congeneric species of similar size, and separation is not possible. Identifications in these cases are made cautiously, and results are described under the families.

The most difficult problem was that there were often no more than two or three reference skeletons available and sometimes only one. These were almost never taken from the same populations as the Yuquot bones, and almost all were from eastern populations and subspecies. Where all the Yuquot examples of one element were slightly larger or smaller than the index element, this was no special problem. But in some cases there were two distinct groups of bones neither of which exactly matched the index bone. In these cases the two groups were judged to be sex- or age-classes. All doubtful identifications or problems are discussed under individual species.

The bones of each species were recorded on a graph of the site and returned to their boxes. Later when the four stratigraphic zones had been established, zone lines were added to the graphs, and element counts and totals were made for each species in each zone. A few bones were not recorded by zone or were from backdirt or postholes and are listed as zone unknown.

To handle the large number of species, the list was arbitrarily divided into two at 22 bones. Those species with more than 22 bones were considered major food species. The two species of large grebes were very close to this line and could have been included in either group. The Kittiwake and Marbled Murrelet had between 40 and 50 bones each, and the shearwater 60. All other major food species had more than 93 bones each. The major species are arranged in ecological groups, and the less common species are arranged in taxonomic order. The two groups are discussed separately.

The minimum number of individuals was calculated by returning to the actual bones. The most frequent element(s) in each zone was taken out and sorted for left and right, proximal and distal portions. Occasionally the size of individual bones had to be considered in possible matches between left and right or between proximal and distal ends. The minimum possible number of individuals was then recorded considering the whole zone as a unit. As the midden accumulated without apparent interruption in the deposits and the zone interfaces are to a certain extent arbitrarily imposed, there is a slight possibility that a part of one individual is counted as one bird in one zone and another part of the same bird as another individual in the contiguous zone. This is most likely to happen when there are a very large number of bones of the species close to the zone interface. But in these species the number of individuals is large, and percentage error from this source would be relatively low.

Grams of edible flesh were calculated from live weights taken from Palmer (1962) and Stewart and Skinner (1967). The amount of edible flesh was considered to be 70% of the live weight following White (1953). The weight of flesh per bird was multiplied by the minimum number of individuals to give estimated minimum figures for flesh from each species for each zone. These are compared to give the relative importance of each avian species in the diet. The total amount of avian flesh for each zone was then calculated for future comparison elsewhere with faunal analyses of Yuquot fish, shellfish, and mammals.

Ratios between front and hind limb bones were made to find out whether selective use was made of these parts. Six shoulder and wing bones (coracoid, humerus, radius, ulna, carpometacarpus, wing digit) were compared with the three hind leg bones (femur, tibiotarsus, tarsometatarsus). The toes were not used because many were not identified. The furcula was not used, because it is fragile and not well represented in the collection. All six shoulder bones were used together as it was thought that selection of any three might bias the results. In an intact bird the six wing bones represent 66% of the total of wing and leg bones. Percentages above this number represent selective use of wing elements and below this number selective use of (or appearance in the midden of) leg bones. Why these results should appear and where the missing bones could have gone is discussed for each species. Burned, worked, or immature bones were recorded and are discussed with each species.

Finally, totals of bones identified and totals of unidentifiable fragments are presented to decide how much the percentage of identifiable bones decreased from zone to zone due to crushing or other damage in the lower levels. Bones found to be unidentifiable late in the study are now included in the fragment totals. Those technically identifiable (at least one articular end partially complete, or a shaft of identifiable shape) but which could not be identified were 55 vertebrae, 137 medium to small toes, 11 small wing elements, and 30 other bones. It is not thought that these represent any new species, or any new individuals.

Distribution information was taken from Munro and Cowan (1947), Palmer (1962), Godfrey (1966), and Martin and Myres (1969).

Species Found in Large Numbers

Species found in large numbers include those common during at least one season of the year, available to the hunting methods of the time, and considered to be edible or otherwise useful. They can be conveniently divided into groups by the habitat in which they are found. This is where the hunter must go to get them, and it also determines the method of capture. Birds frequenting the beach in large numbers were the Bald Eagle, Raven, and Northwestern Crow. On the beach and sea surface were gulls. The diving sea birds can be divided into resident divers including murres and other smaller alcids and most cormorants, migrant divers including loons and grebes, and migrant diving ducks including scoters and mergansers. The albatross and shearwater are non-diving sea birds and summer residents. The geese are migrant winter residents on tidal flats.

The beach and sea surface birds are scavengers feeding on dead or dying organic matter and seldom catching their own live food. They are therefore attracted to the leavings of human hunting and fishing activities. Albatross partly scavenge, though not on shore, and are attracted to offshore fishing and whaling operations. Diving sea birds and diving ducks feed only on live sea animals of their own capture and are therefore not attracted to fish offal or to fishing boats. They may be attracted to traps containing fish eggs or to live baits. Geese feed on plant food and do not generally stay near human activities.

Beach Scavengers

Bald Eagle (Haliaeetus leucocephalus). There are two species of eagle, this species and the Golden Eagle (Aquila chrysaetos). There is complete overlap in size between the two, and their bone structure is indistinguishable. But the Golden Eagle is a year-round resident of high remote mountains and tundra. It is rare at sea level on Vancouver Island (Godfrey 1966: 96). The Bald Eagle, on the other hand, is a common permanent resident of mainland and island coasts. For this reason all of the eagle bones found are attributed to the Bald Eagle. The size of the bones eliminated possible confusion with any but large geese and albatross, but the character of the bones, even of the toes, is very different from these species. The bones were in excellent condition, the long humeri, radii, and ulnas represented by their articular ends for the most part, but many of the carpometacarpi and leg bones were complete despite their size and large air spaces. The toe bones were complete. There were no butchering marks or other cuts indicating non-food use.

This species is by no means the most abundant of the species taken in large numbers, but it is more abundant than the crow, raven, smaller loons, smaller goose, and grebes. At least one individual was found in Zone I, two in Zones II and III, and four in Zone IV. It is noteworthy

that there are twice as many bones and least individuals in Zone IV as in Zone III (Table 1).

The Bald Eagle lives largely near water, nesting in the tops of large trees or occasionally on cliffs. It is non-migratory and a scavenger by preference, eating mostly fish cast up on the beach. If necessary it can catch live fish with its feet by plunging for them from the air. If fish are not available, it will catch birds. Because of its interest in scavenging, it is attracted to offal from fishing operations. Eagles can be captured on the beach with baited hooks, gorges, or snares associated with dead fish. They were also captured by hiding under a mat near bait and grabbing the bird by the legs when it landed (Drucker 1951: 59). The sharp increase in number of bones and individuals in Zone IV is undoubtedly from captures by guns. The flight feathers were used as decorative attachments to ceremonial clothes. Moziño (1970: 15) describes a leather strap hanging from the waist of the war dance dress with four or six parallel lines of strings holding fish bones and eagle quills and occasionally deer hoofs. Eagle down and down from ducks and herons was collected and used in various dances put in a basket-like headdress of cedar (Moziño 1970: 12). This was wafted out during the dance by nods of the head. There were a number of ritual uses of the down: to be sprinkled on the first catch of dog salmon (Drucker 1951: 175) and sockeye salmon (Drucker 1951: 177), to sprinkle the sick, and as a vehicle for return of the soul of the sick person (Drucker 1951: 211-12). Gull down was not used for these ceremonies. Eagles were also eaten, especially in the fall when they were fat from eating salmon (Drucker 1951: 59). Gray, on the voyage of the Columbia 1787-93, describes the natives of Clayoquot adorning the first whale of the season with eagle down.

Northwestern Crow (Corvus caurinus). This is a small crow, so much smaller than the raven and so much larger than other passerines that it presents no problems of identification. A relatively small number of crow bones were found, and almost all were intact. There were no butchering or other marks. This is a species of beaches and tidal flats. It is a permanent resident, nesting and roosting in large coniferous trees near the shore, although there are occasional nests on the ground. It feeds by scavenging along the beach, eating fish and invertebrates brought in by the tide. It is attracted to fish offal and cooking garbage and would have been common on the beach and on the midden itself.

They could easily be captured on the beach or midden with baited hooks or gorges or baited snares. They are tame enough to be stoned successfully. There was a tabu on the eating of crows and ravens (Drucker 1951: 61), which makes it difficult to explain the continuing small numbers of crow and raven bones in the midden. Crows were kept as pets, captured young and allowed their freedom. Most chiefs had special names which only they could use for their pets (Drucker 1951: 109). It would be interesting to know whether this species was considered a small raven in the sense of the folklore or a separate species. Moziño (1970: 103) gives separate names for "common or large crow" (raven?) and small crow. The largest numbers of bones and individuals are found in Zone II. The fewest bones and individuals are in Zone III. Zone IV is intermediate (Table 1).

Table 1. Species Found in Large Numbers

	Total No. Bones						No. Bones (%)					Total Min. No. Indiv.					Min. No. Indiv. (%)			
	I	II	III	IV	ZU*	Total	I	II	III	IV	ZU	I	II	III	IV	Total	I	II	III	IV
Bald Eagle	4	10	36	98		148	2.7	6.8	24.3	66.2		1	2	2	4	9	11.1	22.2	22.2	44.4
Northwestern Crow	3	53	26	37		119	2.5	44.5	21.8	31.1		1	6	2	4	13	7.7	46.1	15.4	30.7
Raven	2	49	22	31		104	1.9	47.1	21.2	29.8		1	4	3	2	10	10.0	40.0	30.0	20.0
Large Gulls	7	100	155	81	13	356	2.0	28.1	43.5	22.8	3.7	2	11	18	12	43	4.7	25.6	41.9	27.9
Mew Gull	1	47	88	34	7	177	0.6	26.6	49.7	19.2	4.0	1	8	10	7	26	3.8	30.8	38.5	26.9
Kittiwake		7	29	6	2	44		15.9	65.9	13.6	94.5		3	5	2	10		30.0	50.0	20.0
Common Murre	9	152	280	106	4	551	1.6	27.6	50.8	19.2	0.7	2	11	25	8	46	4.3	23.9	54.3	17.4
Marbled Murrelet		14	26	9	1	50		28.0	52.0	18.0	2.0		3	6	4	13		23.1	46.2	30.8
Double-crested Cormorant	6	54	31	43	1	135	4.4	40.0	23.0	31.9	0.7	1	7	3	5	16	6.3	43.8	18.8	31.3
Brandt's Cormorant	1	68	51	88		208	0.5	32.7	24.5	42.3		1	4	6	7	18	5.5	22.2	33.3	38.9
Pelagic Cormorant	4	50	53	105	4	216	1.9	23.1	24.5	48.6	1.9	1	4	3	7	15	6.7	26.7	20.0	46.7
Cormorant sp.		1	3	7		11		1.0	27.3	63.6										
Common Loon	1	33	37	34	1	106	0.9	31 1	34.9	32.1	0.9	1	3	3	2	9	11.1	33.3	33.3	22.2
Arctic Loon	3	30	65	89	1	188	1.6	16.0	34.6	47.3	0.5	1	5	6	11	23	4.3	21.8	26.1	47.8
Red-necked Grebe		10	11	16		37		27.0	29.7	43.2			2	2	2	6		33.3	33.3	33.3
Western Grebe		3	8	7		18		16.7	44 4	38.9			1	2	2	5		20	40	40
Large Grebe		5	8	10		23		21.7	34.8	43.5										
Surf, Common Scoter	5	81	84	88	5	263	1.9	30.8	31.9	33.5	1.9	1	8	9	11	28	3.6	25.0	32.1	39.3
White-winged Scoter	3	23	23	49		98	3.1	23.5	23.5	50.0		1	3	3	5	12	8.3	25.0	25.0	41.7
American Merganser	1	24	15	52	1	93	1.1	25.8	16.1	55.9	1.1	1	3	3	7	14	7.1	21.4	21.4	50.0
White-winged Scoter or Merganser		4	4	23	1	32		12.5	12.5	71.9	3.1									
Canada Goose	8	67	50	168	14	307	2.6	21.8	16.3	54.7	4.6	1	10	7	23	41	2.4	24.4	17.0	56.1
Snow Goose	3	20	61	262	6	352	0.9	5.7	17.3	74.4	1.7	1	3	7	19	30	3.3	10.0	23.3	63.3
Black Brant		8	18	90	2	118		6.8	15.3	76.3	1.7		1	4	8	13		7.7	30.8	61.5
Canada or Snow Goose			4	15		19			21.1	78.9										
Short-tailed Albatross	38	386	824	598	41	1887	2.0	20.5	43.7	31.7	2.2	3	29	30	19	81	3.7	35.8	37.0	23.5
Shearwater	1	40	10	7	2	60	1.7	66.7	16.7	11.7	3.3	1	7	3	2	13	7.7	53.8	23.1	15.4
Total for Zone	100	1339	2022	2153	106	5720						22	137	162	173	494				
Species in Small No.	7	92	59	86	2	246						7	43	32	28	110				
Total Identified	107	1431	2081	2239	108	5966						29	180	194	201	604				
% of Total	1.8	24.0	34.9	37.5	1.8							4.8	30.0	32.1	33.2					

* Zone unknown.

Raven (C. corax). The Raven as a very large passerine presented no identification problems. There are fewer Ravens than crows, but a significant number appears in each zone. As in the crow, the largest number of bones and individuals is in Zone II, but the Zone III and IV totals are close together and not far behind (Table 1). The demand for this species throughout time was more even than in the case of the crow. The life style and scavenging habits of the Raven are similar to those of the crow, and methods of capture would be the same. Although this species features strongly in the legends of the coast Indians, there seems to have been little inhibition against capturing it. There is no reference to use of the feathers in the available literature. Although Drucker (1951: 109) describes use of crows as pets, he does not speak of pet Ravens. There was, as with crows, a tabu against eating them.

Large Gulls (Larus sp.). The gulls presented the most difficult identification problems. Each element was sorted to the maximum number of groups by size, but in the large species these groups did not match the sizes of the eastern reference skeletons. Males, females, and various age-groups differ in size, and there is a large overlap between species. The common resident large gull of the coast is the Glaucous-winged Gull (Larus glaucescens), and most of the bones undoubtedly belong to this species. Guiguet (1971: 256) lists the Glaucous-winged Gull as the only gull nesting in the area of Barkley Sound some 80 miles south of Yuquot, and this is probably also true of the Yuquot area. The Herring Gull (L. argentatus) is a much less common bird and present on the coast only in the winter. It nests far inland on the mainland of British Columbia. Herring Gulls made up 15-20% of the gulls in the Barkley Sound area in mid March 1946, but they were rare during the spring and summer, and very few were seen in 1949 (Martin and Myres 1969: 251). The Glaucous Gull (L. hyperboreus), a slightly larger species nesting in the arctic, is a regular winter visitant on the coast. It has been recorded from December to May (Munro and Cowan 1947: 115). Martin and Myres (1969) do not mention seeing the Glaucous Gull in summer on offshore fishing trips along the southwest coast. Because of its scarcity this species probably does not occur in the collection, certainly not in any large numbers. The California Gull (L. californicus) is a transient in small numbers during the spring and fall migrations. They could be numerous for short periods during spring and fall migrations, but most fly high directly overhead and do not land. They nest in the Prairie provinces (Martin and Myres 1969: 251).

Western Gulls (L. occidentalis) nest along the Oregon to California coast, but some winter off the coast of Vancouver Island. Edwards (1968: 200) says the Western Gull is a species of the open coast, while the Glaucous-winged Gull replaces it in sheltered straits. Martin (Martin and Myres 1969: 251) says they made up 5-10% of the gull population of Barkley Sound in mid March 1946, and that they were the most aggressive gull species in competing for fish scraps. Because of this behaviour there is probably an equivalent percentage of Western Gulls in the Yuquot collection. Thayer's Gull (L. thayeri) is a slightly smaller arctic nesting gull which winters in large numbers in the Strait of Georgia. It is apparently not so common on the outer coast of Vancouver Island.

This group of bones showed a large, but inconsistent, range of size. The elements divided into two, three, or four sizes. The largest

bones do not differ from the male L. glaucescens skeleton used. As male Herring Gull and male Western Gull are almost this large, there may be some of these in this group. The smallest bones are smaller than the female Herring Gull skeleton but so much larger than the smaller species that they are clearly very small female Herring Gulls. As some female Herring Gulls were probably larger than this, and because of the composite nature of the larger groups, there are fewer bones in this group in all zones. The middle one or two groups comprise male Herring Gull and female Glaucous-winged Gulls. Some of these middle bones also must represent the rarer species discussed above. In the Zone III deposits there were more middle-sized bones from this group. In Zones II and IV there were more larger and smaller bones. Whether this is sampling error or change in the size of populations of the several species involved is not clear.

The Yuquot people undoubtedly knew the gulls by species as their colour patterns and calls are quite distinct, at least in the adults. But capture of scavengers is unspecific, except where greater aggressiveness makes one species approach baits more fearlessly than another. The Glaucous-winged Gull was the only gull available in summer, all other species being available spring and fall and all but the California Gull in the winter.

Gulls could be taken either on the beach or on the midden itself by hooks or gorges baited with meat, fish, fish offal, or invertebrates. They could also be caught on the beach with baited snares. They could be shot with bows and arrows, but would be difficult to kill with stones because they are very tough. Drucker (1951: 59) speaks of their being trapped during salmon spawning season in the fall. The trap (Drucker 1951: 33) consisted of a frame of lattice held under water and edged with snares. Salmon eggs were thrown underneath as bait. It must have been set in very shallow water as gulls can capture only what they can reach from the surface - they do not dive.

At Yuquot gull down was not used in dances or ceremonies as was eagle and duck down (Drucker 1951: 102). Gulls were kept as pets, captured while young and given their freedom in the village. Some chiefs had special names which only they could use for their bird pets (Drucker 1951: 109).

An interesting peculiarity in the gull collection is that there were so many fewer leg bones than wing and shoulder bones. Some of the legs must have been removed before the birds were returned for cooking or discarded on the midden. There are slightly more total bones and individuals in Zone II than in Zone IV, but almost double this number in Zone III (Table 1).

Mew Gull (Larus canus) (some Kittiwake). This species is a medium-sized gull small enough not to overlap with the preceding group and much larger than the smallest gulls of which only Bonaparte's Gull (L. philadelphia) was found (see birds found in small numbers). There could be a very few bones of Heermann's Gull (L. heermanni) mixed with the Mew Gull bones. This species nests along the west coast of Mexico but disperses in late summer as far north as southern British Columbia. It is sometimes common in Juan de Fuca Strait and off Victoria (Martin and Myres 1969: 251), but it seems to be much rarer farther north. A few Black-legged Kittiwakes (Rissa tridactyla) are probably included here. The coracoids, radii, and ulnas of the two species were not

distinguishable. Mew Gulls are birds of inlets, seldom seen on the open ocean. They are year-round residents nesting on small islands. Methods of capture of these medium-sized species are the same as for large gulls. They would generally be found feeding in mixed gull flocks. As in the large gulls there are relatively few leg bones. It is probable that during the historic period eggs of this species were used as food, but there are no immature bones to indicate regular raiding of gulleries for young birds. As in the large gulls, there are a few more bones in Zone II than Zone IV but the heyday of gull capture was in Zone III (Table 1).

Black-legged Kittiwake (Rissa tridactyla). Bones of Kittiwakes were found in all four zones. This small gull has wing and shoulder bones about the same size as the medium-sized Mew Gull. Its legs are, however, very small, an adaptation for cliff nesting. The eight distal tibiotarsi found were clearly Kittiwake bones. One humerus and two wing digits did not differ from the index skeleton. There were 18 distinguishable carpometacarpi. The coracoids were not distinguishable, nor were the radii and ulnas. There are probably, then, a few Kittiwake bones in with the Mew Gull. Kittiwakes are common migrants on the coast and occasionally winter there. They feed on fish, crustacea, fishermen's waste, and garbage. With the other gulls they could be caught with snares, baited hooks, or gorges on the beach, midden, or in the water.

Diving Sea Birds

Common Murre (Uria aalge). There is only one other possible species here, the Thick-billed Murre (U. lomvia) which is indistinguishable in skeleton but which breeds in the eastern high arctic. Rarely one of this species winters on the west coast (one record in Munro and Cowan 1947: 238). Among murres adult females are very slightly larger than males. Wing length of the male is 192-200 mm with a mean of 196.5 mm, while the female wing is 194.5-204 mm with a mean of 199.9 mm. The overlap is so nearly complete and the means so close that no discernible difference in size of individual bones would be expected. But the radius, carpometacarpus, and femur divide into two or three sharply different groups by length. The largest group must be adult females, the middle group largely adult males, and the smallest possibly young adults. All these bones have articular ends completely fused to the shaft indicating little if any further growth in length, so it may be that all three groups are fully adult with the middle group mixed small females and large males and the smallest groups small males. Almost all of the bones are intact. There are no butchering marks or indications of other than food use.

Murres nest on cliffs or islands. The narrow ledges chosen are usually inaccessible except by climbers with ropes. There is a colony on Triangle Island, B.C. (Godfrey 1966: 197). The young are taken to sea soon after hatching and are common on coasts especially in late summer and fall. They are year-round residents on the coast, but would not be common during the breeding season when they stay closer to the breeding colonies. These birds dive from the surface and swim under water to catch fish. They do not scavenge or eat dead food. They could

be caught with gorges and hooks baited with live fish or in snare traps baited with fish eggs. They could probably not be caught with throw nets while they rested on the sea at night. I think that they would escape such thrown nets by diving.

Marbled Murrelet (Brachyramphus marmoratus). This little alcid occurs surprisingly often in the midden. It is rather small for a food species and is a fish-eating diver and permanent resident. Two other species of similar size occur on the west coast of Vancouver Island. The Parakeet Auklet (Cyclorrhynchus psittaculus) is a slightly smaller bird, but it is only fairly common offshore and rarely seen from land. It is not mentioned in Munro and Cowan (1947) or in Godfrey (1966) as a bird of British Columbia. The other species is the Ancient Murrelet (Synthliboramphus antiquus), also an offshore bird, but with stragglers inshore as a winter resident. These bones were smaller than those of the Ancient Murrelet with the stouter shaft and finer articular ends characteristic of the Marbled Murrelet. One Zone III tibiotarsus was close to the Ancient Murrelet in size but was considered to be one of this group of Marbled Murrelets. Scapulae are not distinguishable, and the one here has been placed with the Marbled Murrelet only on the evidence of the other bones.

All bones were intact, and none had butchering marks. They were presumably caught with other live fish eaters with hooks or gorges baited with fish or possibly in snare traps baited with fish eggs. These birds nest on land, in isolated nests some miles inland. The nest sites are not known at present, and it is not likely that these birds were taken at the nests. The bones are found only in Zones III and IV (Table 1).

Cormorants. There are three species of cormorants available at Yuquot. The largest is the Double-crested Cormorant (Phalacrocorax auritus), next Brandt's Cormorant (P. penicillatus), and the smallest the Pelagic Cormorant (P. pelagicus). In each species males are slightly larger on the average than females but with considerable overlap between males and females. Wing length measurements given in Godfrey (1966: 32-34) and Palmer (1962: 328, 345, 350) show an almost continuous range of sizes with very little overlap between species. These are, however, measurements of whole fresh wings and give only a suggestion of differences in sizes of single bones. There are no characteristics other than size that separate the bones. The reference skeletons seen at the Royal Ontario Museum were from California and somewhat larger than the Yuquot bones. The two smaller species were much closer in size than the two smaller groups from the Yuquot collection and very difficult to distinguish. The Double-crested Cormorant was much larger and heavier and not likely to be confused with the two smaller species, but I suspect that this was a relatively large individual. Very small Brandt's Cormorants could overlap with large Pelagics and be indistinguishable from them.

The Yuquot bones divided clearly into three groups by size, and considering the general size differences discussed above, each was attributed to a separate species. Most of the divisions were quite clean, and there are likely to be few errors. The femur, tibiotarsus, and tarsometatarsus divided easily. The Double-crested Cormorant leg bones included a number much larger than the others and presumably

represent large males. There was also some range of size among the Pelagic leg bones. The humerus and radius were difficult to divide, without a clear division between Brandt's and Pelagic. In the coracoids the lengths of the two smaller species were similar, and they were divided by width of beam, the Pelagic being the more slender. Carpometacarpi and wing digits presented continuous series by length and were divided by robustness of articular surfaces.

Almost all bones were complete, a few cleanly broken into two parts. One Double-crested Cormorant ulna from Zone II consisted of the proximal 3 cm cut off square with three marks parallel to and close to the cut. Another had the distal third cut off square with no marks. A Pelagic Cormorant ulna from the top of Zone III consisted of the distal third with the end cut and one abrasive saw mark. These cuts were presumably made in cutting off the distal half of the wing in preparing the bird for cooking. But most of the ulnas in the collection were not so cut. Four femurs were broken and the rest complete. If severing legs and wing tips before or during preparation was a general practice, it must generally have been done by cutting or breaking the joints.

All three species are divers after live fish and some crustacea. They make long, deep dives from the surface and often catch bottom-living fishes. When not fishing they do not swim, as their plumage gets wet easily. They sit on floating debris or sandbars. They could be captured in the water with hooks or gorges baited with live fish and possibly attracted to snare traps baited with salmon eggs. They could not be caught with lights and nets at night as they are resting on offshore sandbars at this time. Menzies in 1792 (Pearse 1968: 230) speaks of young cormorants in this area as being very palatable.

All three species show the same distribution in zones with most caught in Zone IV (Table 1). The next most frequent was Zone II, and then Zone III. This is the only group showing this type of distribution.

Double-crested Cormorant (Phalacrocorax auritus). This large cormorant nests for the most part far in the mainland interior. There is, however, one colony at Sidney at the southern tip of Vancouver Island. During the later spring and summer the birds stay near their nesting grounds and would not be seen at Yuquot. They are, however, common wintering birds on the whole coast close in to shore where resting places are available.

Brandt's Cormorant (P. penicillatus). This bird nests regularly on small rocky islands along the Washington to California coast and along the west coast of Vancouver Island. They regularly winter there close to shore. A general southeast movement prevails from March through May and some scattered flocks are sometimes seen to the end of June (Martin and Myres 1969: 248-49).

Pelagic Cormorant (P. pelagicus). The Pelagic Cormorant is a common year-round resident nesting on small rocky islands and cliffs. It stays close inshore especially during the nesting season.

Common Loon (Gavia immer). The Common Loon is so much larger than the Red-throated and Arctic species that there is no confusion between them. The shorter bones, carpometacarpus, coracoid, femur, and tarsometatarsus are almost all intact. The larger ones are often broken in half. The bone is heavy, dense, and hard. Although some of the breaks, especially in the ulnas, are shorter than one would expect by chance alone, there are no cuts or other evidence of use.

Loons eat only live fish and some invertebrates, which they catch by diving from the surface and pursuing them under water. They come out of the water only a few feet and then only to reach their nests. They nest in the interior of the mainland, leaving for the breeding lakes in April and returning in October. Some of the non-breeding population remains on the coast in the summer. Loons are seen alone or in family groups of two or three, but not in flocks. They could be caught with gorges or hooks baited with live fish.

The densely feathered bellies of loons and grebes are almost fur-like and, with arctic ducks, much used for clothing by Eskimo groups. But there is no evidence that they were used in this way by Yuquot people. Furs of weasel and mink were sewn into robes for chiefs, and deer, moose, and sea otter skins were also used (Moziño 1970: 15), but there seems to be no record of use of bird skins.

There are relatively few Common Loons in the collection, only about the same number as those of the Raven. It is interesting that their number is constant through Zones II, III, and IV (Table 1).

Arctic Loon (G. arctica). This smaller loon is similar in size to the Red-throated Loon (G. stellata). The Red-throated Loon is slightly smaller and more delicate. There is almost no difference in size between sexes in either species. A few bones were designated as Red-throated Loon (see Species Found in Small Numbers), but there may be a few more mixed with this group of Arctic Loons. The Arctic Loon nests in the arctic and winters on the west coast. It is much more common during migrations than during the winter. Methods of capture and use are the same as given for the Common Loon above. There was one proximal ulna that had been cleanly cut off with an abrasive saw just below the articular end. Most long bones and almost all shorter ones were intact. This was not a heavily used species, but there were more bones than there were of the Common Loon. The numbers increase by half from Zone II to III, and again from Zone III to Zone IV (Table 1). Why the pattern of totals (Table 1) should be different from that of the Common Loon is not clear. Certainly sampling would be the same, and neither species seems to have been especially sought out. Perhaps there had been an increase in populations of Arctic Loons through this time span.

Red-necked Grebe (Podiceps grisegena). This large grebe is much larger than the Pied-billed, Eared, and Horned Grebes which are discussed in the section on bones found in smaller numbers. It is generally somewhat smaller and more delicate than the Western Grebe. But these two species overlap somewhat, and some bones were intermediate in size and were placed separately as "Large Grebes." Females are slightly smaller than males, which increases the area of overlap. Most bones were intact, and there were no cutting marks.

This species and the following Western Grebe, nest in colonies in the mainland interior and winter on the coast. They congregate from

farther south off the coast of B.C. and then move inland in April. They return to the coast in late September or October. They are found in small, very loose associations in the winter, feeding on fish and invertebrates caught by diving and underwater pursuit. They do not scavenge. They could be caught with methods similar to those used for loons. A small number of these birds were found, similar to that of the ravens, and increasing slightly from Zone II to III to IV (Table 1). The minimum number of individuals was only two for each of these zones.

Western Grebe (Aechmophorus occidentalis). This is the largest of the grebes, but with some overlap with the Red-necked Grebe as discussed above. Females are on the average slightly smaller. These birds, like the other grebes, nest on inland lakes and winter on the coast, but they tend to be in much larger congregations. Methods of capture and use are as in the Red-necked Grebes. The numbers of bones are somewhat smaller than those of the Red-necked Grebe, but the least individuals are similar.

Surf Scoter (Melanitta perspicillata) and Common Scoter (Oidemia nigra). There are three species of scoters on the coast: the Surf Scoter, the Common Scoter, and the White-winged Scoter (M. deglandi). The Surf and Common Scoters are much smaller species than the White-winged Scoter. The males in each species are larger, but there is no overlap in size between male Surf and female White-winged Scoters. The Common Scoter is a smaller bird, slightly smaller than the Surf Scoter but with slightly larger legs. Sizes overlap almost completely when males and females are considered together. It was not possible to separate these two species on bone characters. The Yuquot bones divided cleanly into two groups which are considered to be larger White-winged Scoter bones and smaller bones which are mixed Common and Surf Scoters. Since there are no references available that give relative numbers of birds of these two smaller species, no estimates can be made of the percentage of each represented in this sample. Both species are considered to be common winter residents, and both have small non-breeding populations which stay on the coast all summer.

The longer bones, humerus, radius, ulna, tibiotarsus, tend to be broken in half, while the shorter ones remain intact. Many of the breaks are surprisingly straight across, but only one, a Zone III humerus, has a butchering mark, one short stroke near and parallel to the end. The distal third of the bone is severed. This was a popular species, with number of bones and individuals in the range of those of the gulls. The numbers are almost the same in Zones II, III, and IV (Table 1) as in the Common Loon but in no other species.

Scoters gather in large flocks just off rocky shores where the water is shallow and where rocks and tides favour a rich fauna of invertebrates and small fish. They feed on these by diving and underwater pursuit. They arrive on the coast in September or October. By December they are courting, and the flocks become larger and more active. The pairs leave for interior breeding sites in April. Scoters could be captured in traps with snares or on hooks or gorges baited with live fish. Capture by throw nets from lighted canoes is doubtful, although Drucker (1951: 43) includes ducks in the list of birds captured by this method. But these diving ducks would probably dive away from a net thrown onto the surface of the water instead of putting their necks

up through it as the geese did. Drucker (1951: 43) also describes hunting ducks congregated (as the scoters do) just outside the line of breakers. A blind of fir branches was built onto a canoe that would circle out beyond the birds and drift in within bow range, or recently gun range. Scoters are heavy and eatable, though reputed to have a somewhat fishy taste.

White-winged Scoter (*M. deglandi*). Identification of this larger scoter is discussed above. Condition of the bones is the same as above. These birds stayed either in their own flocks or, more often, mixed with other scoters and scaup. Although they were certainly known as a separate species by the Indians, they were undoubtedly caught by the same unselective methods as the other scoter species. The number of bones in Zones II and III (Table 1) is the same and about one fourth of the totals for the two species combined above. The Zone IV total instead of being the same as the others is doubled. This either represents selective capture of this larger species or increased size of populations of White-winged Scoters during historic times. I suspect the latter is more likely.

American Merganser (*Mergus merganser*). This is a large fish-eating duck about the size of the White-winged Scoter. The bones can be distinguished from those of the scoter by characters on the individual bones, but with difficulty. A few bones, vertebrae, scapulae, wing digits, the one fibula, and one tarsometatarsus could not be assigned to species and were put in an either/or group. The smaller Red-breasted Merganser (*M. serrator*) is a winter visitant along the coast (Munro and Cowan 1947: 75), but there is no evidence of the smaller bones of this species.

The bones as in the scoters were intact (shorter ones) or broken in half, often very evenly. There were no butchering marks. There were small numbers of these bones in Zone II, even fewer in Zone III and then double the Zone II number in Zone IV (Table 1). This is similar to, though not identical with, the pattern in the White-winged Scoter.

These birds are resident along the coast nesting in tree cavities or holes in banks, rock piles, or occasionally on the ground (Godfrey 1966: 83) near clear lakes or bays where small fish are available. In addition, there are many migrants from the interior in the winter. They eat only live fish of their own capture and do not congregate in large flocks near the shore. They could be caught with baited hooks or gorges or in snare traps. Because of not being found in flocks, they would not be caught with fire-lighted canoes. Zone IV captures could also be with guns.

Geese

Canada Goose (*Branta canadensis*). This is the largest of the three species of Yuquot geese and so much larger than Black Brant and Snow Geese that there was little difficulty in identification. There are many subspecies or races of Canada Goose, and they differ greatly in size and darkness of colour. These subspecies grade into one another in a complicated manner and are not well understood. The Yuquot bones can be divided into three sizes. The medium size is equal to the largest

specimen in the National Museum of Natural Sciences, National Museums of Canada, but unfortunately the subspecies and locality of this specimen are not known. The small size is the size of ordinary Ontario and Quebec birds. The large size of the Yuquot birds is larger than any of the museum specimens, but the bones are not those of swans. Male and female geese differ very little in overall size of wings (Godfrey 1966: 48), and presumably the bones also are not significantly different. The common subspecies of coastal B.C. is B. canadensis fulva Delacour, a large dark bird. A common migrant to the coast is B. c. minima, a much smaller dark bird. The small-sized Yuquot bones must be B. c. minima. The medium could probably be a B. c. fulva. The very large bones could be especially large B. c. fulva, or one of these groups could be a third subspecies possibly occurring as a migrant.

The number of individuals was computed separately for each size and then added, as it is impossible that a large proximal humerus be from the same animal as a distal small one. The medium and small humeri did not separate and are combined. They are not used in computing minimum numbers of individuals. The numbers of bones and individuals were moderate and about equal in Zones II and III, but they triple in Zone IV (Table 1). Most of the bones were broken and are represented by the articular end and 1 or 2 in. of shaft. The bones are light, thin, and very lightly strutted inside especially in the shaft. The central parts of the shaft are missing and because of their length and fragility must be a large percentage of the crushed unidentifiable fragments. There were no butchering marks, although some breaks were surprisingly straight.

Canada Geese are resident on the coast, some nesting in swamps or lakes and others close to the sea. They feed by dipping their long necks down in shallow water and taking invertebrates and plants. They graze on shore and take grain from wild grasses and grain fields where it is available. Most migrate south, but a few winter at the heads of small inlets. Geese fly along the coast in large flocks during migrations, but I find no information on whether there are traditional resting places within reach of Yuquot. During nesting geese are sufficiently spaced out to be generally uneconomical to hunt. They are extremely wary and are not attracted to human habitations or fishing operations. During migrations they rest in flocks on the sea. They could not be caught by snares or traps as gulls and fish-eating diving waterfowl are. Most were probably caught with throw nets on dark stormy nights when waterfowl congregate in the heads of inlets or deep sheltered coves. As many more geese were caught in Zone IV than earlier, the feasts of many hundred geese referred to in legends (Drucker 1951: 375) may be no older than the beginning of Zone IV. The increase in geese in this latest zone is also no doubt due to the availability of guns.

There is no information on the use of feathers of this species, or of bones. The thin hollow bones with strong, smooth, attractive bone would be a logical choice for any fine hollow implements such as drinking tubes or perhaps beads.

Snow Goose (Chen caerulescens). This is a much smaller goose than the Canada, and most bones were clearly one or the other by size. A few fragmentary sterna could not be distinguished and were left in an either/or section. All the bones fall into a single size category.

Longer bones are represented by halves or more generally the articular end and 1 or 2 in. of shaft. Shorter bones such as tarsometatarsus and carpometacarpus were usually intact. The shafts represent an even larger percentage of the fragment totals than in the Canada Goose because of the numbers of birds taken. Very few Snow Geese were taken during Zone II, a similar number to the Canada Goose in Zone III, and three times the Zone III number in Zone IV. The small numbers of Snow Geese in Zone II may be attributed to the scarcity of this species at that time. If they could catch Canada Geese, they would have caught Snow Geese at the same time had there been any. The increase in Zone IV is certainly due to improved skill in using guns.

These geese are winter residents. Several thousand now winter off Sea Island and Lulu Island at the mouth of the Frazer River. They feed in the shallows and grain fields and rest at night on large sandbars far off the beach. They are extremely wary and cannot be approached without their flying up. They breed in the arctic. I find no record of wintering areas for Snow Geese near Yuquot. They must, therefore, have taken them during migration. There seems to be no information on goose migration up the west coast of Vancouver Island. The Zone II and III captures must have been from fire-lighted canoes on stormy nights. Zone IV captures could have been with guns.

Black Brant (B. bernicla). This very small goose presented no identification problems. It is much smaller than the Snow Goose, and the bone is lighter and thinner than that of sea ducks. The shorter bones were intact, and most of the longer ones broken in half. There were no butchering marks. A very few bones were found in Zones II and III (Table 1) and four times the Zone III number in Zone IV. This is the same sort of arrangement as found in the other species of geese. It is quite different from that found in any other groups of birds, and it presumably represents difficulty of capture before the advent of guns. The "moons of the geese" certainly became more important during historic times. These referred to the spring months when the goose migration took place, and when most of the geese were captured (Drucker 1951: 116).

These birds nest in the arctic and migrate down the coast. A few winter along the southern coast of British Columbia. They feed close in shore on eel grass growing below the high tide line. They graze on these plants at low tide and reach below the water for them at high tide. As they are close to shore, they could have been taken from canoes camouflaged with spruce boughs. They were paddled out and allowed to drift back until in bow and arrow (or latterly gun) range (Drucker 1951: 43). They could also have been taken on stormy nights with throw nets from fire-lighted canoes in sheltered bays. Since they eat no fish, they could not be attracted to bait. During migration the birds fly in flocks of up to 100 relatively low (Kortright 1953: 108) and skirt around hills and bluffs where it would be possible to kill them with guns or arrows. Cook (Journals of Captain James Cook 1967: 1331) notes the occurrence of this species at Yuquot in 1778.

Sea Surface Scavengers

Short-tailed Albatross (Diomedea albatrus). This species of

albatross and the relatively common Black-footed Albatross (D. nigripes) live off the coast of British Columbia. This latter species is larger than the Black-footed Albatross and was of regular occurrence until the turn of the century, when it became nearly extinct and completely disappeared from the British Columbia coast. The third species of northern albatross, the Laysan Albatross (D. immutabilis), is occasionally seen off Alaska but not off the west coast of British Columbia. It does not appear in Martin and Myres (1969) as a bird of southern British Columbia fishing banks.

The bones of albatross are very long, light, and with articular ends more goose-sized than eagle-sized. Their very long wings are for gliding on oceanic air currents, and they are very lightly muscled. The bone is sandy coloured and not shiny or hard. Articular ends are immediately distinguishable by their white chalky appearance. The albatross bones were taken to Dr. Pierce Brodkorb's collection at the University of Florida for species identification. The bones were all much larger than the two D. nigripes skeletons there and the one at the Royal Ontario Museum in Toronto. Four coracoids were sent to Berkeley to the University of California collection, and all were larger than the three D. nigripes in their possession (Sadie Coates personal communication). Femurs and humeri could readily be distinguished by characters unrelated to size, and all Yuquot femurs and humeri were D. albatrus. Coracoids were similarly distinguished by Yesner (1976), but I could not see these differences. On the basis of size and the identification of all femurs and humeri, all Yuquot albatross bones have been designated as D. albatrus.

On the Aleutian Islands five middens have yielded albatross remains (Yesner 1976: 274-76). More than 95% of these were Short-tailed Albatross. The rest were Black-footed Albatross. Albatross bones were not found in middens at Kisameet Bay, King Island, near the north end of Vancouver Island on the mainland (H. G. Savage unpublished data), presumably because this site is in a narrow channel far from the open ocean. There are also no albatross from the Puget Sound, Washington, sites (Miller 1960). Miller (1936: 11) collected many albatross bones, all Short-tailed, from middens on the California coast. Miller (1940: 231) describes the offshore distribution of present day Black-footed Albatross off the California coast. They frequent the turbulent cold water (16°C) over the abrupt drop from the shallow coastal shelf. There they feed on invertebrates, detritus, and some fish. They stay off the shallow shelf itself and are therefore always some miles out to sea. There are now no albatross in the shallower, warmer inshore waters. Miller (1940: 231) quotes Willet as saying that these channel waters were the ecological province of Short-tailed Albatross at the end of the 19th century. Something similar must have been the case off the west coast of British Columbia. There are now no albatross within sight of land. There are Black-footed Albatross commonly in the summer on offshore fishing banks from Washington to Alaska (Martin and Myres 1969). They nest on the Hawaian Islands and other far Pacific Islands in the winter (our winter) and appear offshore on the Pacific coast in March in small numbers. They gradually increase in numbers and group together until in August groups of up to 20 or more can be seen off Ucluelet. In the spring they fly and fish alone, but as they begin to congregate in the summer (no date given), they begin to follow fishing boats for scraps (Martin and Myres 1969: 246).

The few B.C. records of Short-tailed Albatross were from inshore waters off Victoria and in the Strait of Georgia. The Yuquot Indians must have caught Short-tailed Albatross in areas where they did not overlap with the Black-footed Albatross, because there are no Black-footed Albatross bones in the midden. This points to an inshore source of these birds. If the Indians did go out as far as the present-day distribution of the Black-footed Albatross in search of whales, they did not do any albatross collecting there. Also, albatross are very common in the midden at the earliest levels, long before whaling was likely practiced (Dewhirst 1977). This indicates some separation of these functions, unless whales were taken very close to shore within the distribution area of the Short-tailed Albatross.

The number of albatross bones in the midden is astonishing. In the Aleutian middens albatross bones ranged from 4 to 9.5% of the total bones, and 4 to 11% of the minimum number of individuals. At Yuquot 27-40% were albatross bones, depending on the zone, and 9-16% of the minimum number of individuals were albatross (Table 2). The number of bones so overwhelms those of all other species that it could be referred to as an albatross midden. Albatross individuals dominate Zones I and II, but there are more individual murres in Zone III and more individual Canada Geese in Zone IV (Table 1). The higher the number of individuals in the midden, the greater is the number of bones per individual (Tables 2 and 3).

Table 2. Per Cent of Zone Totals

	No. Bones					No. Individuals				No. Bones/Indiv.			
	I	II	III	IV	ZU*	I	II	III	IV	I	II	III	IV
Bald Eagle	3.7	0.7	1.7	4.4	0.0	3.4	1.1	1.0	2.0	4.0	5.0	18.0	24.5
Northwestern Crow	2.8	3.7	1.2	1.7	0.0	3.4	3.3	1.0	2.0	3.0	8.8	13.0	9.3
Raven	1.9	3.4	1.1	1.4	0.0	3.4	2.2	1.5	1.0	2.0	12.3	7.3	15.5
Large Gulls	6.5	7.0	7.4	3.6	12.0	6.9	6.1	9.2	6.0	3.5	9.1	8.7	6.8
Mew Gull	0.9	3.3	4.2	1.5	6.5	3.4	4.4	5.1	3.5	1.0	5.9	8.8	4.9
Kittiwake	0.0	0.5	1.4	0.3	1.9		1.7	2.6	1.0		2.3	5.8	3.0
Common Murre	8.4	10.6	13.4	4.7	3.7	6.9	6.1	12.8	4.0	4.5	13.9	11.2	13.3
Marbled Murrelet	0.0	1.0	1.2	0.4	0.9		1.7	3.1	2.0		4.7	4.3	2.3
Double-crested Cormorant	5.6	3.8	1.5	1.9	0.9	3.4	3.9	1.5	2.5	6.0	7.7	10.3	8.6
Brant's Cormorant	0.9	4.8	2.4	3.9	0.0	3.4	2.2	3.1	3.5	1.0	17.0	8.5	12.6
Pelagic Cormorant	3.7	3.5	2.5	4.7	3.7	3.4	2.2	1.5	3.5	4.0	12.5	17.7	15.0
Cormorant sp.	0.0	0.1	0.1	0.3	0.0								
Common Loon	0.9	2.3	1.8	1.5	0.9	3.4	1.7	1.5	1.0	1.0	11.0	13.3	17.0
Arctic Loon	2.8	2.1	3.1	4.0	0.9	3.4	2.8	3.1	5.5		6.0	10.8	8.1
Red-necked Grebe	0.0	0.7	0.5	0.7	0.0		1.1	1.0	1.0		5.0	5.5	8.0
Western Grebe	0.0	0.2	0.4	0.3	0.0		0.6	1.0	1.0		3.0	4.0	3.5
Large Grebes	0.0	0.3	0.4	0.4	0.0								
Surf, Common Scoter	4.7	5.7	4.2	3.9	4.6	3.4	3.9	4.6	5.5	5.0	11.6	9.3	8.0
White-winged Scoter	2.8	1.6	1.1	2.2	0.0	3.4	1.7	1.5	2.5	3.0	7.7	7.7	9.8
American Merganser	0.9	1.7	0.7	2.3	0.9	3.4	1.7	1.5	3.5	1.0	8.0	5.0	7.4
White-winged Scoter or Merganser	0.0	0.3	0.2	1.0	0.9								
Canada Goose	7.5	4.7	2.4	7.5	13.0	3.4	5.6	3.6	11.4	8.0	6.7	7.1	7.3
Snow Goose	2.8	1.4	2.9	11.7	5.6	3.4	1.7	3.6	9.5	3.0	6.7	8.7	13.8
Black Brant	0.0	0.6	0.9	4.0	1.9		0.6	2.1	4.0		8.0	4.5	11.3
Canada or Snow Goose	0.0	0.0	0.2	0.7	0.0								
Short-tailed Albatross	35.5	27.0	39.6	26.7	38.0	10.3	16.1	15.4	9.5	12.7	13.3	27.5	31.5
Shearwater	0.9	2.8	0.5	0.3	1.9	3.4	3.9	1.5	1.0	1.0	5.7	3.3	3.5
Species in Small No.	6.5	6.4	2.9	3.8	1.9	24.1	23.9	16.9	13.9				

* Zone unknown.

Table 3. Elements of Species Found in Large Numbers

	Zone	Skull	Premaxilla	Mandible	Quadrate	Vertebrae	Coracoid	Scapula	Furcula	Sternum	Sacrum	Humerus	Radius	Ulna	Carpometacarpus	Carpo-ulna	Wing Digit	Distal Wing Digit	Alula	Femur	Tibiotarsus	Fibula	Tarsometatarsus	Toe	Claw	Total	Least Individuals
Beach																											
Bald Eagle	IV					9	2	5	4	1		2	3	4	4	3	1	4	7	4	4	4	5	20	12	98	4
	III					1				1	1	3	2	2	3		2	2	2	2	2			7	6	36	2
	II									1		2					2				1			2	2	10	2
	I											1			1										2	4	1
	ZU*																										
	Total																									148	9
Northwestern Crow	IV			1			3	1				7	1	8	3					3	7		3			37	4
	III						1					6	1	5	3		1			4	4		1			26	2
	II						6				2	1	1	9	5		2			6	12		9			53	6
	I												1		1						1					3	1
	ZU																										
	Total																									119	13
Raven	IV			1			2	1				5	6	4	3					2	2	1	3	1		31	2
	III			1			1			1		1	2	4	6		2			1	3					22	3
	II			1		10	6	2				5	2	2	4		3			3	6	1	4			49	4
	I							1				1														2	1
	ZU																										
	Total																									104	10
Beach & Sea Surface																											
Large Gulls	IV					1	12	2	1	2		17	9	4	17		9	1		1	2		3			81	12
	III		1	2		5	31	9	4	5		26	21	9	13	1	11	3	1		6		7			155	18
	II	1		1		2	3			1		18	11	10	18	1	12	5	1	2	7		7			100	11
	I			1			1	1				2		1			1									7	2
	ZU																										
	Total																									356	43
Mew Gull	IV						7	3		1		5	1	9	1		2	1		3	1					34	7
(Some	III			2			17	5	1	8		21	6	12	5		6			2	3					88	10
Kittiwake	II			2			3	1				6	9	17	4		1	4								47	8
coracoid, radii,	I											1														1	1
ulnas)	ZU						2	1				2		1			1									7	
	Total																									170	26
Kittiwake	IV														2						3		1			6	2
	III								1			2			8		1				7		10			29	5
	II														6		1									7	3
	I																										
	ZU														3											2	
	Total																									44	10
Resident Divers																											
Common Murre	IV	3		3		6	14	7	1	5		16	6	12	11		5			7	3		7			106	8
	III	3		12	1	10	20	9	5	7	2	33	39	50	38		10			16	11		12			280	25
	II			1		11	14	8	2	5		28	8	24	7		5	1		14	18		6			152	11
	I									1		3		1						1	1		2			9	2
	ZU							1				1		2												4	
	Total																									551	46
Marbled Murrelet	IV						1					1	1	6												9	4
	III						2					8	1	8	6						1					26	6
	II						1					4	1	4	3						1					14	3
	I																										
	ZU							1																		1	
	Total																									50	13
Double-crested	IV					1	8			2	1	3	3	4	2					8	5	1	5			43	5
Cormorant	III						4			1	2	4	3	2			3	1		5	4		2			31	3
	II					1	1	1	1	1	1	4	8	2	4		7			1	10	3	9			54	7
	I										1	1	1							1	1		1			6	1
	ZU																				1					1	
	Total																									135	16
Brandt's	IV			4		3	10	3			4	13	3	5	12		3			11	7	5	5			88	7
Cormorant	III					2	4	4			1	8	2	3	5		1			5	2		14			51	6
	II						5	3			4	7	7	4	11		4			4	8	4	7			68	4
	I												1													1	1
	ZU																										
	Total																									208	18
Pelagic	IV		1	8		21	7	3	1	5	6	11	4	3	8		3			7	7	2	8			105	7
Cormorant	III		2	1		10	4	4		2	1	4	3	3	4		2			3	4	2	4			53	3
	II			2		4	3	3		1	1	8	2	3	8		4			2	4	1	4			50	4
	I					1								1									1			4	1
	ZU			1								1					1				1					4	
	Total																									216	15
Cormorant	IV					7																				7	
	III					3																				3	
	II					1																				1	
	I																										
	ZU																										
	Total																									11	

*Zone unknown.

Table 3. Cont'd.

	Zone	Skull	Premaxilla	Mandible	Quadrate	Vertebrae	Coracoid	Scapula	Furcula	Sternum	Sacrum	Humerus	Radius	Ulna	Carpometacarpus	Carpo-ulna	Wing Digit	Distal Wing Digit	Alula	Femur	Tibiotarsus	Fibula	Tarsometatarsus	Toe	Claw	Total	Least Individuals
Migrant Divers (Winter)																											
Common Loon	IV					2	2		1	3	2	3	2	3	6		4				1		2	3		34	2
	III	1				1	2	3	1		1	2	2	1	1		1		1	2	2	1	6	9		37	3
	II					2	1					3	2	4	6			2		2	1		1	9		33	3
	I			1																						1	1
	ZU																				1					1	
	Total																									146	9
Arctic Loon	IV			2		21	23	2			5	6	4	4	4		1			2	6		9			89	11
	III	1		2		11	4	1		2	1	9	4	5	10		2			4	4	1	4			65	6
	II	2					1	1					3	4	7					1	1		8	2		30	3
	I														1								2			3	1
	ZU													1												1	
	Total																									188	23
Red-necked Grebe	IV					1		2				2	4	3						1	1		2			16	2
	III							1				2	3	5							1		1			13	2
	II											3	2	3						1			1			10	2
	I																										
	ZU																										
	Total																									37	6
Western Grebe	IV									1				2	3					1						7	2
	III							1				1			1		1			1	1		1			6	2
	II																			1			2			3	1
	I																										
	ZU																										
	Total																									18	5
Large Grebes (2 above species)	IV					2	1		1		1				1					2			2			10	
	III	1					3	1						1	1								1			8	
	II	2	1																				2			5	
	Total																									23	
Migrant Diving Ducks (Winter)																											
Surf Scoter	IV						11				1	15	3	16	17		13			5	4		3			88	11
*Common scoter	III						17	4	1		3	11	6	9	14		3			9	4		3			84	9
	II						10					10	4	13	13		4			4	11		12			81	7
	I						1							2	1					1						5	1
	ZU											1		1	2						1					5	
	Total																									263	26
White-winged Scoter	IV	1					5		4	2		6	10	2	3		2	2	1	4	6		1			49	5
	III						2			1		3	4	1	3					3	6					23	3
	II						1			1		1	4	4	9				2	2	5					23	3
	I											1	1	1												3	1
	ZU																										
	Total																									98	12
American Merganser	IV						3		1			8	12	11	14					1	1		1			52	7
	III			1			1			1		1	1	5	2					1	2					13	3
	II											1	4	7	4					2	4		2			24	3
	I																				1					1	1
	ZU								1																	1	
	Total																									93	14
American Merganser or White-winged Scoter	IV					9		7									5					1	1			23	
	III					4																				4	
	II							2									2									4	
	I																										
	ZU																1									1	
	Total																									32	
Migrant Geese (Winter)																											
Canada Goose	IV	1				1	26	11	22	6		32	18	8	17		10	3	3	5	3		2			168	23
	III						8	5	3	5		6	6	1	4		6			2	2	2				50	7
	II						3		2	3		4	9	6	16	1	9	3	4	2	4		2			67	10
	I						1					1	2		2					1	1					8	1
	ZU						2	2	3			4	2					1									14	
	Total																									307	41
Snow Goose	IV		1			4	36	37	18	8	3	47	25	5	17		8	4	5	14	16	1	13			262	19
	III					1	15	9	8		1	8	2		5	1	1	1		2	3		4			61	7
	II					1	1	2	1					4	2		2	3			2	1	1			20	3
	I											1	1				1									3	1
	ZU						2	1	1				1						1							6	
	Total																									352	30
Canada or Snow Goose	IV									15																15	
	III									4																4	
	II																										
	I																										
	ZU																										
	Total																									19	
Black Brant	IV					8	12	14	1			15	6	5	4		5		1	3	10		6			90	8
	III	1					3					6	2		2		1		1	1	1					18	4
	II			1		1		1				2					2				1					8	1
	I																										
	ZU																1				1					2	
	Total																									118	13
Offshore Migrant (Summer)																											
Short-tailed Albatross	IV	6	8	30	2	106	47	22	8	8	17	62	12	9	16	1	22	14	2	12	20	26	5	19	115	598	19
	III	7	4	17	5	218	65	51	19	18	27	47	12	13	17	1	24	18		6	34	44	14	40	123	824	30
	II	1				11	5	4		1	1	14	24	18	33		53	36	1	12	7	25	5	35	97	386	29
	I					6	3	2		1	2	4			2		1	2			4	2		1	8	38	3
	ZU			6		2	6	3			2	5		2			3					5	1	1	9	41	
	Total																									1887	81
Shearwater	IV											1	1	3	1								1			7	2
	III												1	3						3			3			10	3
	II											6	10	14						3	2		5			40	7
	I																						1			1	1
	ZU												1										1			2	
	Total																									60	13

But there are more albatross bones per individual than would be expected. There are very large numbers of vertebrae and toes, many more than in any of the other groups, even considering the difficulty of identifying these small elements.

Albatross toes:	IV	21	18	18	8	16	8	11	15	115
	III	21	31	20	11	19	4	10	7	123
	II	22	17	14	11	13	3	10	7	97
	I	2			1	1	3		1	8
	ZU*	2			1	2				5
	Total									348

* Zone unknown.

This points to some differences in the handling of the birds. More of their bones reached the midden than in the other groups. Perhaps, because of their large size and very long wings, the meat was removed from the carcass for cooking and the rest put on the midden. Albatross were eaten in Alaska (Pearse 1968: 102 quoting Langsdorff 1905). There is no evidence that the skins were used for clothing as in the Aleutians, nor is there any evidence that they were used for floats.

All but a few of the bones are represented by their articular ends only. Most of the light hollow shafts were crushed and are seen as an important component of the fragment weights and numbers. Four tibiotarsi were cut with abrasive saws, one in Zone III and three in Zone II. Three femurs were similarly cut in half, one in Zone IV and two in Zone III. The tibiotarsi are meatless and could have been cut off for cooking. The femurs are well covered with meat, but most of it is at the proximal end. The meat could have been pushed up and the lower half of the femur cut off. Six proximal and three distal ulnas are cut off evenly, two from Zone III, and one from the bottom of Zone IV. These again may have been made in removing the long distal wing sections for cooking. Only eight of the 47 Zone III humeri are distal fragments; the rest of the distal ends are missing. The long straight shafts of all these bones could also have been used in the manufacture of tubular implements.

The Black-footed Albatross follows boats in late summer and approaches even non-fishing boats apparently out of curiosity (Miller 1940: 229-38). It takes scraps from fishing vessels, settling on the water and swimming up to them. Baited hooks and gorges are taken readily and the birds easily pulled to the boat. In calm weather albatross cannot rise from the water and can be approached with a small boat and clubbed with paddles. Birds captured in this manner by the natives were brought to the explorers in the Aleutians in the 1800s (Pearse 1968: 102). Short-tailed Albatross are said to be shy and not to follow boats (Alexander 1955: 8), but this may not have been true before they were severely persecuted on the nesting grounds. But even if they did not approach boats, they could be caught when they could not fly up from the water because of lack of wind. They could also have been caught with baited hooks or gorges set on traps, and possibly in

snare traps baited with salmon eggs.

Shearwater (Puffinus sp.). The Greater Shearwater (Puffinus gravis) of the east coast of North America was the only shearwater available for comparison. Femurs were the same size as the Greater Shearwater with one smaller. The ulnas were slightly stouter than those of the Greater and 2 cm shorter. Radii were 2 cm shorter also. Two of the tarsometatarsi were the same, the remainder, 6 mm shorter. The members of this genus are very similar and overlap considerably in size, but there are four species about this size on the west coast in the summer. They all breed elsewhere and would be absent in the winter. The Slender-billed Shearwater (P. tenuirostris) is a smaller bird with much shorter wings, probably too small for these bones, and rare (Martin and Myres 1969: 248). The Pale-footed Shearwater (P. carneipes) is about the right size but also rare. The Pink-footed Shearwater (P. creatopus) is about the right size and a scarce but regular summer bird on the coast (Godfrey 1966: 22). All three follow boats and accept scraps. They could be taken with baited hooks or gorges during fishing trips. The fourth species, and the most abundant, is the Sooty Shearwater (P. griseus). This bird is slightly smaller than the Greater Shearwater, but of the size range of the Yuquot bones. It would, however, be very difficult to catch, since it does not follow boats or accept scraps. Shearwaters are too active to be clubbed with paddles, and they can fly up from the water regardless of the condition of the wind. They are pelagic birds flying and gliding close to the water to pick up live small fish and crustacea. They congregate in areas of upwelling where such food is plentiful and rarely come close to land.

The humeri and tibiotarsi were all distal halves. Half of the radii were in halves, both proximal and distal. Femurs and tarsometatarsi were mostly complete. There were no cutting marks. This was one of the least common of the major food groups, and the largest number of bones and individuals was in Zone II (Table 1).

Major Food Species

There are 23 major food species. Three of these are scavengers inhabiting the beach: the eagle, raven, and crow. Three are gulls scavenging both the beach and sea surface. Among the diving, fish-eating sea birds are two alcids, three cormorants, two loons, two grebes, and three species of diving ducks. There are three species of geese, living on the sea and some land areas and eating plants and some invertebrates. Offshore are the albatross and shearwater, both feeding on fish and invertebrates while gliding over the open ocean and both attracted to fishing boats. In short, all species of medium to large size which were available in any quantity were utilized for food.

Of these groups six are dominant throughout the time period of the excavation. These are the albatross, geese, gulls, cormorants, diving ducks, and the murre. The others, the eagle, crow, and raven, and the loons and grebes, play a lesser role. The loons and grebes are less common on the coast and often found singly rather than in large groups. The eagle, crow, and raven were similarly found in small numbers and had to be captured singly. It was the large groups of birds that were most successfully exploited for food.

Among the six dominant groups some changes in rank take place during the time period (Table 4). Considering first the minimum number of individuals, the albatross is the dominant bird in Zones I and II, then drops to second to the gulls in Zone III and finally to fourth in Zone IV. The geese were sixth in Zone I, then fourth in Zones II and III and first in the historic period displacing the albatross, gulls, and diving ducks. The gulls were popular table birds, always being in the top three and in Zone III being the most common individuals in the midden. The murre was low in this first group at first but reached third in Zone III. The diving ducks like the geese increased in favor to second after the geese in Zone IV. Cormorants were regular staples, high in Zones I and II and dropping in Zones III and IV.

Table 4. Rank by Numbers of Bones and Minimum Numbers of Individuals

	No. of Bones				Min. No. Indiv.			
	I	II	III	IV	I	II	III	IV
Albatross	1	1	1	1	1	1	2	4
Geese	3	6	5	2	6	4	4	1
Cormorants	2	2	4	3	2	3	5	4
Diving Ducks	5	5	6	4	4	5	6	2
Gulls	6	3	3	5	3	2	1	3
Murre	4	4	2	6	5	6	3	7
Eagle	7	9	10	7	9	10	9	10
Loons	8	7	7	8	7	8	7	6
Crow, Raven	8	8	9	9	8	7	8	8
Grebes	-	10	8	10	-	9	8	9

In Zone I the avian fare (minimum number of individuals) consisted of albatross, cormorant, gulls, and diving ducks with the additions of murres and geese. By Zone II the first three remained the same, but the gulls became more frequent than cormorants and geese, diving ducks and murres. By Zone III gulls were the most common birds slightly eclipsing even the albatross, and the murres were third, making the major birds gulls, albatross, and murres. Geese, diving ducks, and cormorants were behind. In Zone IV geese increased spectacularly. Diving ducks were close behind, then gulls and the equal rated cormorants and albatross. Loons became sixth displacing the murres from the top group. It must be noted that although geese and diving ducks were used more often in Zone IV, gulls, cormorants, and albatross continued to be caught and eaten in large numbers.

When bone totals are considered, the albatross dominates the midden. Even if the large numbers of albatross toes and vertebrae are subtracted from the total, there are 1196 albatross bones and 796 goose bones from all zones.

Species Found in Small Numbers (Fewer than 22 Bones)

Red-throated Loon (G. stellata). This loon is, in general, slightly smaller and more delicately built than G. arctica, but there is almost complete overlap in length of bones. The smallest bones of loons (those with the narrowest articular ends) have been ascribed to this species. They formed a definitely separable group in the Yuquot material. All of these bones are broken, most with about one third of the length of the shaft remaining. Only one shows a butchering mark. This Zone III ulna (just below the border with Zone IV) shows a cut ½ in. below the distal end. Most of the distal articular end is missing, but it seems to be broken off. Presumably the cut resulted from separation of the wrist joint in preparation for cooking. One Zone IV ulna was blackened at the proximal end. Red-throated Loon bones are found in all zones, but only a few in each. These birds winter close to the coast, arriving from the breeding grounds in September and leaving in May and early June. There are many leisurely migrants from the California coast coming through at these times. Diving fish eaters, they could be caught with hooks or gorges baited with fish.

Grebes. The three species of small grebes are represented here. There is a Zone III complete femur and a Zone II tibiotarsus that are similar in size to the Eared Grebe (Podiceps caspicus), a Zone II tarsometatarsus from a Horned Grebe (P. auritus), and two Zone IV tarsometatarsi from the Pied-billed Grebe (Podilymbus podiceps). The Horned Grebe tarsometatarsus is complete. The Eared Grebe tibiotarsus is missing the distal end, and the Pied-bill bones are a proximal and distal end. Like the loons, these birds winter off the coast from November to the end of March or April. Pied-billed and Horned Grebes are relatively solitary, but Eared Grebes sometimes congregate in bays in large groups. These are small birds weighing only 250-500 g live, and they would presumably not have been prime targets for food. They feed by diving for small fish and invertebrates and would probably not take large pieces of fish used as bait for larger birds. Eared and Horned Grebes have attractive gold feathers on their faces in the spring and all have very dense pearl-white breast feathers. These birds were possibly picked up injured or dead on the beach for the feathers, or caught in snare traps.

Northern Fulmar (Fulmarus glacialis). As the only middle-sized procellariiform except the shearwater, the fulmar presented no identification problems. They are found in Zones II, III, and IV, but not in very large numbers in any one zone. There are fewer in Zone IV than in the earlier zones (Tables 5, 6). All but one of the coracoids are complete; the scapula is represented only by the proximal half. These birds are regular transients on pelagic waters, throughout the year, occasional individuals coming inshore. They eat fish and crustacea, are attracted to fishing operations for fish offal, and feed

Table 5. Species Found in Small Numbers (Fewer than 22 Bones)

	No. Bones					Min. No. Indiv.					Total	Total
	I	II	III	IV	ZU*	I	II	III	IV	ZU	Bones	Indiv.
Red-throated Loon	1	3	3	10		1	1	2	1		17	5
Eared Grebe		1	1				1	1			2	2
Horned Grebe		2					1				2	1
Pied-billed Grebe				2					1		2	1
Fulmar		8	6	4			2	2	1		18	5
Fork-tailed Petrel		2	2	4			2	1	2		8	5
Brown Pelican			1					1			1	1
Great Blue Heron	1	5	2	2	1	1	1	1	1		11	4
Whistling Swan		2					1				2	1
White-fronted Goose		2	2	4			1	1	1		8	3
Mallard		2	1	1	1		1	1	1		5	3
Pintail	1		1	2		1		1	1		4	3
Green-winged Teal			1					1			1	1
American Widgeon		1					1				1	1
Scaup		5	5	9			2	2	2		19	6
Goldeneye		2	4	6			2	1	1		12	4
Bufflehead		3		6			2		3		9	5
Old Squaw		1	1				1	1			2	2
Peregrine		1	2				1	1			3	2
Sparrow Hawk		3	1				2	1			4	3
Ruffed Grouse		7		12			2		2		19	4
Sora			1					1			1	1
Killdeer				1					1		1	1
Greater Yellowlegs				1					1		1	1
Dowitcher				1					1		1	1
Black Turnstone				3					2		3	2
Sanderling		1					1				1	1
Bonaparte's Gull	1		1			1		1			2	2
Pigeon Guillemot	1	5		4		1	1		1		10	3
Tufted Puffin			1					1			1	1
Rhinoceros Auklet			5	3				2	1		8	3
Cassin's Auklet	1	1		1		1	1		1		3	3
Screech Owl		1	2				1	1			3	2
Great Horned Owl		2					1				2	1
Saw-whet Owl			1					1			1	1
Snowy Owl		1					1				1	1
Belted Kingfisher		10	4				4	1			14	5
Red-shafted Flicker		1					1				1	1
Yellow-bellied Sapsucker		3	1				1	1			4	2
Horned Lark			2					1			2	1
Steller's Jay	1	3	3			1	2	2			7	5
Robin		2	3	1			1	1	1		6	3
Red-winged Blackbird		11	2	9			3	1	2		22	6
Fox Sparrow		1					1				1	1
Zone Total	7	92	59	86	2	7	43	32	28			
Small No. Total											246	110
% of Total	28	37.4	24.0	35.0	0.8	6.4	39.1	29.1	25.4			

* Zone unknown.

Table 6. Elements of Species Found in Small Numbers (Fewer than 22 Bones)

	Sex	Skull	Premaxilla	Mandible	Quadrate	Vertebrae	Coracoid	Scapula	Furcula	Sternum	Humerus	Radius	Ulna	Carpometacarpus	Carpo-ulna	Wing Digit	Distal Wing Digit	Alula	Femur	Tibiotarsus	Fibula	Tarsometatarsus	Toe	Claw
Red-throated Loon	IV							2				1	2	2			1			1	1			
	III													1										2
	II											1				1				1				
	I															1								
	ZU*																							
Eared Grebe	IV																				1			
	III																							
	II																				1			
	I																							
	ZU																							
Horned Grebe	IV																							
	III																							
	II											1												1
	I																							
	ZU																							
Pied-billed Grebe	IV																							4
	III																							
	II																							
	I																							
	ZU																							
Pelican	IV			1				1								1					1			
	III							5						1							1		1	
	II							1	1			1		3							2			
	I																							
	ZU																							
Fork-tailed Petrel	IV												2		1	1					1			
	III													1										
	II												2											
	I																							
	ZU																							
Brown Pelican	IV																							
	III			1																				
	II																							
	I																							
	ZU																							
Great Blue Heron	IV												2											
	III														1					1				
	II												1		2	1					1			
	I																			1				
	ZU												1											
Whistling Swan	IV																							
	III																							
	II												1				1							
	I																							
	ZU																							
White-fronted Goose	IV			1				1													1	1		
	III							1													1			
	II							1								1								
	I																							
	ZU																							
Mallard	IV																				1			
	III																				1			
	II							1			1													
	I																							
	ZU																							
Pintail	IV															2								
	III															1								
	II																							
	I															1								
	ZU																							
Green-winged Teal	IV																							
	III													1										
	II																							
	I																							
	ZU																							
American Widgeon	IV																							
	III																							
	II													1										
	I																							
	ZU																							
Scaup	IV							1					3	4	1									
	III												3	2										
	II												3	2										
	I																							
	ZU																							
Goldeneye	IV												1		2	1					1	1		
	III							1					1			1					1			
	II															2								
	I																							
	ZU																							
Bufflehead	IU												3		1	2								
	I A																							
	II												1		2									
	I																							
	ZU																							
Old Squaw	IV													1										
	III													1										
	II																							
	I																							
	ZU																							
Peregrine	IV																1							1
	III																							
	II						1																	
	I																							
	ZU							1																
Sparrow Hawk	IV													1										
	III													2							1			
	II																							
	I																							
	ZU																							
Ruffed Grouse	IV	1						1		1			3								3	2		
	III																							
	II												2	1	3	1								
	I																							
	ZU																							
Rare	IV																							
	III												1											
	II																							
	I																							
	ZU																							

Table 6. Cont'd.

	Sex	Skull	Premaxilla	Mandible	Quadrate	Vertebrae	Coracoid	Scapula	Furcula	Sternum	Humerus	Radius	Ulna	Carpometacarpus	Carpo-ulna	Wing Digit	Distal Wing Digit	Alula	Femur	Tibiotarsus	Fibula	Tarsometatarsus	Toe	Claw
Killdeer	IV													1										
	III																							
	II																							
	I																							
	ZU																							
Greater Yellowlegs	IV												1											
	III																							
	II																							
	I																							
	ZU																							
Dowitcher	IV																							1
	III																							
	II																							
	I																							
	ZU																							
Black Turnstone	IV												1											
	III																							
	II																							
	I																							
	ZU																							
Sanderling	IV																							
	III																							
	II												1											
	I																							
	ZU																							
Bonaparte's Gull	IV																				1			
	III																							
	II																							
	I						1																	
	ZU																							
Pigeon Guillemot	IV					1								2	1									
	III												1	1	2						1			
	II												1											
	I																							
	ZU																							
Tufted Puffin	IV																							
	III													1										
	II																							
	I																							
	ZU																							
Rhinoceros Auklet	IV												1	1										
	III		1				1								2	2								
	II																							
	I																							
	ZU																							
Cassin's Auklet	IV													1										
	III																							
	II												1											
	I																				1			
	ZU																							
Screech Owl	IV												1								1			
	III													1										
	II																							
	I																							
	ZU																							
Great Horned Owl	IV																							
	III													1										
	II																							1
	I																							
	ZU																							
Saw-whet Owl	IV																							
	III													1										
	II																							
	I																							
	ZU																							
Snowy Owl	IV																							
	III																							
	II													1										
	I																							
	ZU																							
Belted Kingfisher	IV																							
	III																							
	II												1	1	1	1								
	I												1	2	5	2								
	ZU																							
Red-shafted Flicker	IV																							
	III														1									
	II																							
	I																							
	ZU																							
Yellow-bellied Sapsucker	IV																							
	III																				1			
	II						1					1		1										
	I																							
	ZU																							
Horned Lark	IV																							
	III																				1	1		
	II																							
	I																							
	ZU																							
Steller's Jay	IV																							
	III													2										1
	II													2	1									
	I														1									
	ZU																							
Robin	IV																				1			
	III																					2		1
	II													1								1		
	I																							
	ZU																							
Red-winged Blackbird	IV								1		3		3									2		
	III												3											
	II												4		5									
	I																							
	ZU																							
Fox Sparrow	IV																							
	III																							1
	II																							
	I																							
	ZU																							

on whale carcasses. They could be caught by baited hooks or gorges near whole carcasses or butchering places for marine mammals or fish. Fulmar are in the acceptable food range at 600-800 live weights.

Fork-tailed Petrel (Oceanodroma furcata). There are two possible petrels in this area, the Fork-tailed Petrel and Leach's Petrel (O. leucorhoa). Leach's Petrel is much more common. The bones of (O. furcata) are wider and flatter in the shaft and heavier in the articular ends. These bones are clearly O. furcata. A few bones are found in each of Zones II, III, and IV (Tables 5, 6), and all bones are complete. These birds skim the surface for small fish, crustacea, and oil from wounded seals and whales. They are very small birds (live weights average 45 g) so they would be of no interest as regular food, nor would they have been brought home from a whale hunt. They must have been picked up dead on the beach.

Brown Pelican (Pelecanus occidentalis). Both this species and the White Pelican (P. erythrorhynchos) are casual visitors on the coast (Munro and Cowan 1947). Moziño (1970: 112-13) includes them in his list of 1792, but they are not in Swarth's (1912: 21) list. They are large and conspicuous water birds and being fish eaters and scavengers, they could be caught with the regular food species. They must not have been very common, or they certainly would have appeared more often in the midden. Pelican bones are very thin and fragile and are more likely than the bones of most species to be crushed in the midden. This species is represented by one Zone III mandible end.

Great Blue Heron (Ardea herodias). The few bones of this species are found in all zones, each in small numbers. The bones are very long and fragile and are represented in the collection as articular ends. Only the wing digit is complete. All but one of the 11 bones are from the pectoral girdle. Perhaps the meatless legs were discarded before the bird was brought home. These birds are common in sheltered bays where they stand waiting for live fish and crustacea. They are never seen in groups except at the breeding sites. As they take only live food, they could not be caught with baited hooks, traps, or snares, but it would be feasible to stalk them and stone them or shoot them with arrows. Their plume-like head feathers might be attractive, and they are large enough to be considered for meat (2200 - 2600 g live).

Whistling Swan (Olor columbianus). Whistling and Trumpeter (O. buccinator) Swans are found on Vancouver Island. The Whistling Swan is seen only as a spring and fall migrant, an occasional sick or injured bird being left behind in the winter. Most of the migration is inland from lake to lake, so they would be rare at Yuquot. Trumpeter Swans winter on Vancouver Island, some on lakes and ponds, but most on inlets at the mouths of rivers. Smith (1973: 58), does not say whether the west coast inlets are wintering grounds, but they are probably not, considering the small number of swan bones in the midden. There are a distal humerus and distal wing digit, found together in Zone II. They were attributed by their small size to the Whistling Swan. Swans feed on crustacea and plants while swimming in shallow water and stirring up the bottom with their feet. They don't come out of the water to feed on grain as much as geese do. These birds could have been netted from

fire-lighted canoes, shot with bows and arrows, or be dead or injured birds picked up on the beach.

White-fronted Goose (Anser albifrons). This middle-sized goose was very difficult to distinguish reliably. There was considerable variation in size in the Snow Goose, but in general the White-fronted Goose had a little finer and more delicate articular ends. The mandible, carpometacarpus, three coracoids, two femurs, and tibiotarsus included here did not differ from the index skeletons. The radii and tarsometatarsus were indistinguishable in the two species, and tibiotarsi, ulnas, and carpometacarpi were close.

It is therefore possible that there were more White-fronted Geese utilized than it appears from these tables. It is also possible that all these bones were from Snow Geese. All were complete and in excellent condition except the tibiotarsus which was the distal half and one proximal coracoid. Zones II, III, and IV (Tables 5, 6) provided examples. White-fronted Geese are common migrants on the west coast and occasionally winter there. They would have been caught with the other species of geese from fire-lighted canoes or by bow and arrow.

Mallard (Anas platyrhynchos). Only a single complete coracoid, two femurs, and a sternum fork represent this species. They were too large to be any other species of surface feeding duck. These birds winter commonly on the coast feeding by tipping-up in very shallow water or on land. This is not an easy bird to catch, as it cannot be taken with baited hooks and is extremely wary. It could be taken by a throw net from a fire-lighted canoe, but it is more likely to spend the night on land. It was possibly taken by bow and arrow or by snare traps baited not with fish but with salmon eggs.

Pintail (A. acuta). This species is represented by complete carpometacarpi only, one from Zone I, one from Zone III, and two from Zone IV (Tables 5, 6). The species of this genus are difficult to distinguish, but these bones are clearly Pintail. This species nests in the interior of the province but is common on the coast during migration and during the winter. It feeds by tipping-up in shallow water and feeding on invertebrates and plants on the bottom. It could be caught with snare traps baited with fish eggs or with bow and arrow. As it spends the night on shore, it would be difficult to catch with a throw net.

Green-winged Teal (A. carolinensis). This small surface-feeding duck is represented by a complete ulna from Zone III. Green-winged Teal nest in fresh water, but on migration and in winter (Godfrey 1966: 59) they use shores and shallow salt water. These small, very shy ducks may have been hunted for the bright irridescent green patches on the wing. They could have been caught in snare traps or with throw nets, but not by baited hooks as they do not dive or eat fish.

American Widgeon (Mareca americana). One complete Zone II ulna represents this species. This is a non-diving duck similar in size and habits to the Pintail. Details of habits and capture are the same.

Scaup (Aythya sp., probably Greater Scaup, A. marila). The two scaup ducks overlap almost completely in size, and the bones are indistinguishable, but the Lesser Scaup is scarce on the coast and the Greater Scaup a common winter resident. There are one coracoid, three complete ulnas and other distal ends, two complete radii and proximal ends, and one proximal carpometacarpus. The distal end of the ulna is larger and more rounded than that of Melanitta perspicillata but otherwise the same length and size. The radii are extremely close, and there is some danger of mixing them. The carpometacarpus is very worn on the proximal end, but it is more like scaup than any other duck and is so placed here. All other elements are indistinguishable from M. perspicillata and a few may be included there. The lack of leg bones may be, then, an accident of identification. As these birds loaf and feed in large flocks close to shore and feed on fish and crustacea by diving, they could be caught by gorges, snare traps, bow and arrow, and throw nets from fire-lighted canoes. They would be available from October through March.

Goldeneye (Bucephala sp., probably Barrow's Goldeneye, B. islandica). The two species of goldeneye are too similar for positive identification, but Barrow's is the much more common species. These ducks winter in large flocks and commonly idle with scaup and scoters only a few feet off the shore at Vancouver. They must be much less common at Yuquot, since as diving fish-eaters they can be caught with baited gorges, snare traps, bow and arrow, or throw nets at night. Wing bones predominate, and the only leg bones are two femurs and one tibiotarsus.

Bufflehead (B. albeola). This smallest of the diving ducks can easily be separated by size from the other diving species and by characters from the Green-winged Teal which is of similar size. The bones were all wing bones, the ulnas and carpometacarpi complete, and humeri represented by distal halves. They come from Zones II and IV (Tables 5, 6). It breeds on fresh water lakes near woods, and winters on salt water in bays and estuaries. Bufflehead dive for food and take only live food, fish, and invertebrates. They could be caught with the larger fish eating ducks, and although small would be enjoyed as food.

Old Squaw (Clangula hyemalis). Only one ulna from Zone II and one from Zone III (Tables 5, 6) were found. One is complete. The other is the proximal two thirds and has been burned until it is white and abnormally curved. Old squaw coracoids are similar to Bucephala; the distal humerus is difficult to separate, but all other elements are easily separable. These small diving sea ducks winter in large flocks, but not in my experience close to shore. They could not be taken regularly by baited hooks or traps near shore. These may have been unusual birds which did come in close enough for canoe netting with lights, to be caught in traps or with bow and arrow, or they may have been disabled specimens picked up on the beach. The wing bones remain here as in the teal, but in this species there are no especially attractive colour patterns on the wing.

Peregrine Falcon (Falco peregrinus). A wing digit and claw of this species were found in Zone III deposits, and there is a coracoid of

unknown zone. A Zone II proximal scapula was identified by Howard Savage at the Royal Ontario Museum. This bird is nowhere common, because suitable high cliff nesting sites are rare. It nests regularly on the Pacific coast near areas where waterfowl congregate or near sea bird nesting colonies. It winters along the coast feeding on birds taken only in the air. It would be impossible to trap this bird on the ground or sea, and resting and nesting sites are generally inaccessible. These birds were either picked up dead or the trophy of some skilled climber's assault on a nest. Since the bones are those of adults, the former is more likely.

Sparrow Hawk (F. sparverius). The Zone II proximal tibiotarsus and one distal ulna were found together. The other distal ulna was some 3 ft. vertically above them and may represent another individual. Another individual is represented by one ulna in Zone III (Tables 5, 6). Skeletons of Osprey, Goshawk, Sharp-shinned Hawk, and Marsh Hawk were available for comparison, but none of these birds were found in the Yuquot collection. They all migrate along the west coast regularly, and the Osprey breeds there. It is surprising that these species do not appear in the midden, but none appears in the Puget Sound, Washington, middens (Miller 1960: 392-97) either. Perhaps they do not hunt from perches and are therefore inaccessible. The Sparrow Hawk breeds on Vancouver Island, and some winter there. It utilizes open areas, hunting large insects and small rodents and birds from regular perches on dead trees or other vantage points. It could easily be trapped or snared on these perches. This is a small (robin-sized) bird which seems hardly a good source of food, but it is very attractive and easily kept in captivity tied with a string to a perch. It will accept meat from the hand. These birds were probably such captives. Perhaps its kinship with the eagle made it especially interesting.

Ruffed Grouse (Bonasa umbellus). At one spot in the top 6 in. of Zone IV were the remains of two Ruffed Grouse: three femurs, a pair of coracoids, a pair of humeri, one tibiotarsus, one skull, and a sternum. All but the femurs and sternum were complete. A humerus near the surface but some distance from the first group and a distal tibiotarsus 3 ft. below may represent other individuals. These were almost certainly taken with a shotgun for food. There are no Zone III specimens. In Zone II a humerus, two ulnas, a proximal radius, and a damaged carpometacarpus are found close together and a proximal humerus and an ulna some distance from each other, possibly representing three specimens. This is the only galliform species present. This species uses second growth deciduous and mixed woodland, wood edges, and alder and willow-bordered stream beds. It does not favour mature forests, but uses conifers for cover. This bird bursts suddenly out of cover, flying erratically, and hides. They could be struck with stones or arrows only with great difficulty. Males could be snared on their regular drumming logs in the spring. In dense undergrowth they would not be likely to be picked up dead or disabled from natural causes. They are, however, very good eating. Because of either habitat preference or speed, they don't seem to be easily available. The larger and slower Blue Grouse is surprising in its absence in the midden. It is resident on Vancouver Island in openings in conifer forests and winters in conifers, but perhaps it does not occur close to the coast. There were two Blue

Grouse bones found in the Puget Sound middens (Miller 1960: 392-97), but, there as here, there seems to have been little attempt to capture birds in the forest.

Sora (Porzana carolina) This is a small rail, an invertebrate eating bird of fresh or salt water marshes. It does not wade but feeds and nests in grassy edges of marshes. Only one damaged proximal humerus of this species was found. The other species of small rail, the Virginia Rail (Rallus limicola), was not represented nor was the duck-sized swimming Coot, a common fresh water marsh rail. The Sora would not have been caught by regular methods and would be too small for regular eating. They are very shy and generally are heard in the marsh and not seen. It was probably found dead or stoned by children. The feathers are not bright coloured but are grey and brown, beautifully striped, and bordered with black and white.

Shore Birds. Five small shore birds were identified, four from single bones, one from three humeri. The first was a Zone IV distal humerus from one of the medium-sized shore birds. Shore birds have very delicate bones whose articular ends are very similar. Size and length (if the bones are complete) are useful clues. This bone was about the size of, although not exactly equal to, the Greater Yellowlegs (Totanus melanoleucus). There is no other shore bird about this size.

The Zone IV tarsometatarsus is attributed by size to the Dowitcher (Limnodromus sp.). The tarsus of the Long-billed Dowitcher (L. scolopaceus) is larger than that of the Short-billed (L. griseus). The Yuquot tarsometatarsus measures close to the top limit of the Short-billed Dowitcher measured in the flesh, so it could be either. The Stilt Sandpiper is also a possibility by size, but it very rarely comes to the coast, migrating through the middle of the continent. The Wandering Tatler is also of similar size but rare, the Killdeer of similar length but heavier.

Three Zone IV humeri were identified as Black Turnstone (Arenaria melanocephala). Two were found together and seem to be a pair. The other was some distance away, but all were within a foot of the surface. The closely-related A. interpres is rare on the coast. These bones were longer than male A. interpres from Labrador. The only plover of similar length of wing is the Killdeer (Charadrius vociferus), and it is much sturdier than this humerus.

The fourth species is the only shore bird found below Zone IV. It is an intact humerus from a small sandpiper from Zone II. This bone is slightly longer than that of the Sanderling (Crocethia alba) taken in the Northwest Territories but of the same characteristic slimness. There is no other shore bird of this size with such slender wing bones. All of these species found in the Yuquot midden are common on beaches during migration in March and April and again in August and September. Black turnstone and a few Sanderling winter on the coast.

The fifth species is the Killdeer represented by an ulna from Zone IV. The Killdeer is a breeding bird on the coast. It is tame and conspicuous during the breeding season and unlike the other shore birds, it has bright-coloured tail feathers. It is surprising that it does not appear more often in the midden. All these species could be stoned on the beach or caught in snares. Sprot (1928: 142) describes snares used at Barkley Sound and says that they were used for shore birds. They are

too small to be of much interest for food and were perhaps caught and played with by children. Drucker (1951: 451) speaks of hummingbirds and other small birds being tied with a string through eyes or nostrils and made to fly in circles.

Bonaparte's Gull (L. philadelphia). Two bones of this very small gull were found, an almost complete coracoid from the top of Zone I and a femur from Zone III. These birds are common migrants on the coast and occasionally winter there. They would have been caught while hunting other scavengers or picked up dead on the beach. They would not have been especially sought out for food as their larger relatives are twice the size and three times the weight, but certainly not rejected either. They are delicate and pretty and could possibly have been kept captive either free or tied by one leg.

Pigeon Guillemot (Cepphus columba). Ten bones of this species were identified, one from Zone I, five from Zone II, and four from Zone IV (Tables 5, 6). They were complete (femur) or broken in halves or thirds. This is a common year-round resident of the Pacific coast nesting on rocky islands in small colonies or single pairs. They build their nests in crevices in talas or small ledges on cliff faces and winter in the area of the nesting sites. As there is no evidence of young birds in the Yuquot material, the adults caught were certainly feeding on the sea. They feed on fish and crustacea by diving and could be caught with any gear set out for diving birds.

Tufted Puffin (Lunda cirrhata). This species is represented by one Zone III radius. The Puffin is a larger species than the Rhinoceros Auklet, but very similar and having a large size range within the species. This bone was larger and wider than the comparable auklet bones and equaled in size and shape a small female puffin in the collection. Puffins are common summer birds on the coast, nesting in burrows on small islands. They migrate out of the area in the winter. They dive for fish and could be caught in snare traps or with baited gorges. They could also be caught at nesting colonies, although, if this were the case, more bones would be expected and some would be expected to be juvenile.

Rhinoceros Auklet (Cerorhinca monocerata). This alcid is smaller than the Pigeon Guillemot and puffin but much larger than the murrelets. It is resident on the west coast of Vancouver Island, nesting in colonies on wooded islands. It winters in small numbers along the coast. The bones were from Zones III and IV (Tables 5, 6) and were all slightly damaged though complete. This is a diving fish eater. It could be caught in snare traps or with baited gorges. It is not large but well within the size range that would have been used for food.

Cassin's Auklet (Ptychoramphus aleuticus). This is the only very small alcid on the west coast. The Least Auklet is not found south of the Aleutians and is not listed in Munro and Cowan (1947) as a bird of British Columbia. Cassin's Auklet is a summer resident of the west coast of Vancouver Island, nesting in burrows on small islands. It is rare in winter. It dives for live food and does not come ashore except

to nest. Three bones of this species were found, one each from Zones I, II, and IV (Tables 5, 6). The tibiotarsus is complete, the humerus represented by the proximal end, and the radius by the distal two thirds. Because of its very small size (2.5 cm shorter and very much lighter than the murrelets), it was certainly not sought out for food and would not have been caught in a throw net or dead or injured on the beach. It might be taken in a snare trap baited with salmon eggs.

Owls. Seven owl bones were found, a distal humerus and femur from Zone III and distal ulna from Zone II of the Screech Owl (Otus asio), a complete tarsometatarsus and distal ulna from Zone II of a Great Horned Owl (Bubo virginianus), a proximal humerus from Zone III of a Saw-whet Owl (Aegolius acadicus), and a Zone II proximal radius from a Snowy Owl (Nyctea scandiaca) (Tables 5, 6). All but the Snowy Owl are nocturnal woodland birds, the Screech Owl preferring open deciduous woods but coming close to houses. The Saw-whet prefers dense coniferous or deciduous woodland or dense alder and cedar thickets. Both these small owls nest in old woodpecker holes or other cavities in trees. They could be trapped at their nests or possibly at daytime roosting places, although these are usually well hidden. The birds are tame in the daytime and if the resting places were found, they could possibly be taken by hand and with stones. They are not at all likely to be found dead. The small owls could be kept captive and are easily tamed if taken young. It is interesting, though, that the Saw-whet humerus has five light marks on the ventral surface near the head, where presumably attempts were made to disarticulate the wing from the body. Perhaps the wing was kept for a time for decoration and then abandoned on the midden. It is doubtful that these small birds were used for food.

The Great Horned Owl lives in dense or open deciduous or coniferous forest and nests on conspicuous platforms built on old hawk or crow nests in the tops of large trees. The bone found is that of an adult, probably trapped on a regular daytime resting perch, or stoned there. The birds are tame and conspicuous in the daytime and small birds often call noisily around them. This bird is large enough to have been valuable for food. The feathers are decorative, and it is possible that even this large bird was kept captive, tied to a perch. Short-eared and Pygmy Owls are also resident in the area, but were not represented in the Yuquot collection.

One proximal radius from Zone II represented a juvenile Snowy Owl. These owls breed in the arctic and are not normally migratory. But in years of poor food supply a number of these birds move south, some as far south as the United States border. Most do not survive. This young bird must have been captured in the fall of its first year. They are diurnal birds and perch on poles and rocks in open country. A white owl in a society that values owls would have been an important find. The bird could have been stoned, shot with an arrow, or picked up dead or dying. This is the only juvenile bird in the Yuquot collection.

Belted Kingfisher (Megaceryle alcyon). Four kingfisher bones were found in Zone III deposits. A complete ulna and proximal radius found together at the bottom of the zone represent one specimen, a distal humerus and possibly the carpometacarpus probably another. The Zone II bones are a right proximal and right distal ulna found together but not from the same bird, a distal humerus and proximal ulna close

together, a distal ulna and proximal radius close together, and another distal ulna and radius and two carpometacarpi. By counting lefts, rights, and lengths of sections a minimum number of four specimens is obtained, but the actual total is probably five. Although all but one of the long bones are broken, they have no butchering marks. The Kingfisher is a regular summer resident on the coast and occasionally winters there. It hunts fish in clear shallow water, either salt or fresh, by diving from an exposed dead stub or branch. It nests in burrows dug in vertical faces of earth banks, usually near the top. This small bird would have been caught not for food but for the brilliant blue feathers on its head, back, wings, and tail. (The bones found are all wing bones.) It could have been snared or stoned at its regular fishing perches. The nests are not likely places for capture as they are very deep and usually inaccessible. Or they could have been picked up dead or disabled on the beach. They are more likely to be found in the marsh and lake area behind the village than on the open beach, because of the perch requirement.

Woodpeckers. One carpometacarpus of the Red-shafted Flicker (Colaptes cafer) was found in Zone II. A humerus, ulna, and coracoid of the Yellow-bellied Sapsucker (Sphyrapicus varius) were found together in the middle of Zone II, and a tibiotarsus in Zone III (Tables 5, 6). These bones were all complete, but the Zone II sapsucker bones had damaged places on the ends. There were no butchering marks. Both species are year-round residents on the coast. The Red-shafted Flicker is the woodpecker of open woodlands and clearings with nearby trees for resting and nest holes. It feeds on the ground, largely on ants. The Yellow-bellied Sapsucker likes deciduous or mixed woodlands especially where there are aspens. It feeds in trees and nests in tree holes. Four other woodpeckers are available on the coast, Lewis's Woodpecker (Asyndesmus lewis), another open country species, and the large Pileated Woodpecker (Dryocopus pileatus) whose scarlet crest would make it attractive, but which is shy and lives high up in dense coniferous woods. The two smallest woodpeckers, the Downy (Dendrocopos pubescens) and Hairy (D. villosus) Woodpeckers, live in open but mature woods. As they are black and white and very small, they seem to have been of no interest. In the Yellow-bellied Sapsucker the whole head and neck are bright red. In the Flicker the red patches are small, but all the feathers have conspicuous and unique red shafts. Both these species could be taken with stones or arrows, the flicker while feeding on the ground, the sapsucker while feeding at its regular sap-gathering stations on aspen trees. They were presumably taken for feathers, and not for the small amount of meat.

Passerines. Five species of perching birds appear in the Yuquot sample. These very small bones are exceedingly well preserved and most are complete. The largest species represented is Steller's Jay (Cyanocitta stelleri). The seven bones indicate one specimen from Zone I and two specimens from Zones II and III (Tables 5, 6). These were too large to be the Canada Jay (Perisoreus canadensis) which is resident in the coast forest but seldom below 1000 ft. (Smith 1973: 62). Canada Jays were not seen during the summer of the excavation (J. Dewhirst personal communication). The deep blue of the wings and tail of the Steller's Jay would have made it the more attractive of the two species.

It is a year-round resident of mixed and coniferous forests. A bold scavenger, it could have been taken with snares or stones on the midden itself.

Horned Lark (Eremophila alpestris). The second of the passerines is represented by a Zone III femur and tibiotarsus found together. This was a difficult identification. The bones were slightly smaller than those of the eastern reference skeleton. They were, however, smaller than robin, redwing, crossbill, and Fox Sparrow; wider than pipit; and bigger than waxwing, vireo, and various sparrows. The Horned Lark is resident on Vancouver Island but not documented for the west coast. It lives in open rocky or gravelly areas feeding on insects and seeds of sparse plants and grasses. Perhaps this one was picked up dead in such an area or snared. The plain brown feathers would be of no particular value, and it is much too small to be considered as food.

Fox Sparrow (Passerella iliaca). The other difficult and surprising passerine find was a complete tarsometatarsus from near the bottom of Zone II. This bone is larger than those of most sparrows, lark, pipit, grosbeak, Pine Grosbeak, Cedar Waxwing, and vireos and smaller than Robin, thrushes, Red-winged Blackbird, and Starling. It is close to the Rufous Tohee but slightly shorter. It was decided on the basis of size that this must be a Fox Sparrow. Tarsometatarsi are the easiest bones to deal with on this basis, because there are published tarsal length ranges for the fresh skins of all species. These are very close to the length of the bone itself. Fox Sparrows are resident on the coast in scrubby woods and stream edges, feeding on the ground by scratching noisily in the leaves for invertebrates. This is a large dark brown sparrow with a rusty tinge. Its feathers are not colourful, and it would not be seen in cleared areas near the village or on the beach. It could not be readily trapped or snared and would not be found dead. This one was perhaps stoned in the woods by children.

Robin (Turdus migratorius) An ulna and a tibiotarsus were found in Zone II, two tibiotarsi and a tarsometatarsus in Zone III, and a femur in Zone IV (Tables 5, 6). Two other species of thrushes belong in the west coast fauna, the Varied Thrush and the Hermit Thrush. Both these are slightly smaller species. The Hermit Thrush is a shy bird of mature deciduous forests, and would not be found in open areas. The Varied Thrush is also a forest bird, but it comes into open areas to feed on wild fruit trees in the winter. The Robin is a year-round resident in open woods and open areas, nesting and roosting in trees but foraging for invertebrates (mostly earthworms) on the ground. It does not take dead food, but could be snared or killed with stones. The deep red feathers of the breast might be attractive, but the bird is quite small for a food species (total length 20-23 cm).

Red-winged Blackbird (Agelaius phoeniceus). This is the most common passerine in the midden. There were six humeri and five ulnas rather widely distributed in Zone II and two ulnas in Zone III. At the bottom of Zone IV there were two humeri, three ulnas, and one distal tibiotarsus found together. A sternum, a tibiotarsus, and a proximal humerus were found separate from each other at some distance from the first group (Tables 5, 6). This species lives in marshes perching and

nesting in the reeds and feeding on insects. In the fall and winter they gather with other blackbirds into large flocks roosting together and feeding in fields. These birds were probably captured in the nesting marshes with snares or stones. Only two of the 22 bones are leg bones. All the others except the one sternum are the bones of the wing associated with the bright red and yellow wing patches. It is surprising, however, that no radii were found. One of the Zone II humeri is complete, but it has four fine scratches near the distal end, presumably made in an attempt to dismember it there.

Discussion - Species in Small Numbers

Species found in small numbers (fewer than 22 bones) are summarized in Tables 7 and 8. These 44 species are listed in taxonomic order to make it easier to compare this list with other faunal lists. Table 7 shows some of the aspects of the relationship of these species to the Yuquot people, where they were found and how they may have been used.

Table 7. Ecological Breakdown of Birds Found in Small Numbers (Fewer than 22 Bones)

	Minor Food Species		Non-food Species	
	Large	Medium to Small	Small to Very Small Bright Coloured	Very Small Plain Coloured
Sea	Fulmar Swan White-fronted Goose Brown Pelican	Red-throated Loon Eared Grebe Horned Grebe Pied-billed Grebe Mallard Duck Pintail Scaup American Widgeon Green-winged Teal Goldeneye Duck Bufflehead Old Squaw Pigeon Guillemot Tufted Puffin Rhinoceros Auklet		Fork-tailed Petrel Cassin's Auklet
	Taken incidentally to hunting regular food species			
Beach	Great Blue Heron	Bonaparte's Gull*		Greater Yellowlegs Dowitcher Black Turnstone Sanderling Killdeer
Village			Red-shafted Flicker Steller's Jay Robin	Horned Lark
Marsh	Snowy Owl		Red-winged Blackbird Belted Kingfisher	Sora
Forest	Great Horned Owl	Peregrine Falcon* Ruffed Grouse Sparrow Hawk*	Yellow-bellied Sapsucker Sparrow Hawk*	Screech Owl* Saw-whet Owl* Fox Sparrow
Totals	7	18	7	12
	25		19	

* Could be kept captive. Total captives = 5.

All but two of the sea birds are large or medium in size and were probably taken incidentally in the hunt for the more common sea birds which formed the main avian food staples. The petrel and Cassin's Auklet are the only small sea birds. The auklet could have been taken with the food species; the petrel was probably picked up dead. All of these species were well within the food size range, but are less common residents of the coast fauna, being either found singly or mixed with the more common food species.

Among the beach birds the gull must certainly have been caught incidently to food hunting for the larger gull species. The Great Blue Heron must have been especially sought out or killed when seen. It could not have been caught with other species. The four sandpipers must have been snared or stoned.

In the village and associated open areas were three bright-coloured species taken presumably for their feathers and one drab one, but no species large enough to be used for food. (Gulls and crows could have been taken at the midden, but these are discussed with the major food species.) We know very little about the use of feathers at Yuquot. They were used in dancers' head bands, but Drucker (1951: 102) says that they expressed no preference for particular species. He says that hawk and eagle feathers were used, and when white was wanted, swan feathers were available. This reference to swans is doubtful since only one swan was found in the midden. The white feathers could have been snow goose or albatross. Eagle and duck down was used in dance head bands and ceremonially (Drucker 1951: 102, 175, 177, 211). Quills were used for bird snares set under water, and for braces to hold fibre snares open (Drucker 1951: 34). Narrow strips of the ribs of feathers were used to join the cattails used in weaving hats (Moziño 1970: 15). There is no mention of the use of coloured feathers. Perhaps they were prized by children and not used ceremonially by adults.

None of the major food species are birds of the marsh or forest. They apparently did not hunt regularly for food in these areas. The marsh and forest species found in the midden must have been hunted in areas entirely separate from those of the usual food hunts. Four of the 12 species have bright feathers, four would be interesting captives (plus possibly the Great Horned Owl). Only the grouse is a good food species. The owls and hawks could, by their size, also be eaten.

Table 8. Weights and Numbers of Bones and Fragments

	I	II	III	IV
Weight of avian material (g) (total 12,797 g)	237.5	3101.2	4469.8	4900.1
% of weight/zone	2.6	24.2	34.9	38.3
% of no. bones identified/zone	1.8	24.0	34.9	37.5
% of minimum no. indiv./zone	4.8	29.8	32.2	33.2
% of no. fragments/zone	2.1	23.4	31.3	43.1
% of no. bones and fragments/zone	1.3	23.8	33.0	41.2

The list can finally be divided into two sections. First is species of sea and beach birds that were taken in conjunction with the regular avian food hunts. They represent acceptable, though sometimes smaller than usual, food species which are less common on the coast. Second is five large- or medium-sized and 19 small or very small species that were hunted separately, all in different areas or by different methods from the regular hunts. These probably represent hunting efforts of children.

Missing Birds

All possible species of loons, grebes, cormorants, geese, sea ducks, crows, the eagle, the kingfisher, and the heron are represented in the collection. It is probable that all the gulls are there too. Very small sea birds such as petrels are selected against, and several species are missing. At the same time, small alcids are represented, being fish eaters. The small beach birds, sandpipers and their relatives, while certainly common, were sampled very sparingly, and a large number of species is not represented. All species likely to enter the village were taken. Marsh and forest birds were poorly represented in species as well as in numbers of bones, and a great many species of woodpeckers, hawks, owls, and especially small passerines are not found in the collection. Small birds were not of much interest to these food gatherers, nor were forest or marsh species.

In addition, there are several whole families of birds present in the area that do not appear in the collected material. The most conspicuous of these is the hummingbird. The species found at Yuquot is the Rufous Hummingbird (Selasphorus rufus). This is a tiny (8-9 cm) irridescent green and copper bird which is a common summer resident on the coast. The Journals of Captain James Cook (1967: 1330) say that a large number were brought to the ship for sale. Drucker (1951: 451) reported that they were captured and kept by children as toys with a string through the eyes or nostrils. Jewitt, a prisoner at Nootka from 1802 to 1805, reports hummingbirds common at a small pond near the village (Pearse 1968: 260). Drucker (1951: 451) reported that they were captured by smearing slug slime on twigs in the vicinity of flowering plants. When the birds landed on the sticky twig, their feet were entangled, and they could not take off. Several could be caught on one patch of slime, one after the other. Hummingbird bones are very small and cartilaginous and may have been lost in screening during excavation or have disintegrated entirely in the midden. The length of the bird is about half the length of the Fox Sparrow whose perfectly preserved tarsometatarsus was found well down in Zone II. The wing bones of hummingbirds are surprisingly strong, but the legs are very small.

The Osprey (Pandion haliaetus) is a large conspicuous bird seen occasionally on the coast in summer. It catches live fish by plunging for them from the air and is seldom a scavenger. Swarth (1912: 21) lists the Osprey at Nootka, but Moziño (1970: 112-13) does not. It did not appear in the excavation.

The Sandhill Crane (Grus canadensis) migrates along the coast and occasionally nests on the southern half of Vancouver Island. It is not included in the list from Swarth's (1912: 21) summer visit, and the reference in Moziño (1970: 113) is doubtful, probably a Great Blue Heron. The log of the San Carlos in 1791 (Pearse 1968) also mentions cranes, but these could be herons also. The crane is a shy bird living in marshes, tundra, and wet fields. Although it could appear in the marsh near Yuquot, it is not likely. Certainly it does not appear in the collection.

The Band-tailed Pigeon (Columba fasciata) is a large (36 cm) pigeon of open woodlands, where it eats wild fruits and berries. It perches in high trees. Both Moziño (1970: 113) and Swarth (1912: 21) list it. Since most forest hunting seems to have been done by children, perhaps these edible birds were out of reach. At any rate there are none in the collection.

The American Coot (Fulica americana) is said to breed on inland lakes on Vancouver Island and winter on the coast of the island (Godfrey 1966: 127). It probably does not come up as far north on the west coast as Yuquot or it would certainly appear in the midden. It is a surface feeding water bird, but could be netted with the ducks or shot.

There were no domestic pigeons, chickens, or ducks even in Zone IV deposits. Where garden space is so limited, there is little room to spare for the necessary grain for winter feed for domestic birds. No grains could be brought to maturity in the narrow strip of cultivated land (Moziño 1970: 7). Also a wide variety of wild sea birds could be harvested in the spring and fall, and several species in the summer, without caring for them. The seasonal migration to the inlets for the winter would also be difficult with large flocks of domestic birds. In general, birds seemed to be an occasional addition for a change of diet and not a staple even on a seasonal basis.

There is only one immature bone in the collection. This is the radius of a Snowy Owl, doubtless an immature migrant not captured at a nest. The island breeding sites of gulls, cormorants, and alcids were within reach along the coast, but young birds seem not to have been hunted there. Cormorants and alcids nest on cliffs and could be difficult to capture, but gulls nest on open ground on islands. This does not rule out the possibility that they took eggs from such colonies. Loons, grebes, and most geese and ducks nest in the interior of the province and are, except for the stragglers, away from Yuquot in the summer. Drucker (1951: 61) says that gull eggs were not eaten until recent times, when they were said to have learned the use of them from the Haida and Tsimshian. He also says that children staged mock battles with eggs, which would indicate that they were not highly coveted as food.

Weight of Avian Bone

The avian material was weighed and the weights recorded. Totals from each zone are seen in Table 8 and compared to other measures of the quantity of avian material. There was very little avian bone in Zone I (2.6%), 20% more in Zone II (24.2%), 10% more in Zone III (34.9%), and slightly more in Zone IV. Correlations with per cent of numbers of identified bones in each zone is very close. That with per cent of numbers of least individuals in the zone is less so because of the tendency of this measure to over-emphasize groups with smaller numbers of bones. Surprisingly the per cent of numbers of fragments per zone gives the most inconsistent figures. Zones I and II are close, but Zone IV has 4.8% more fragments than would be expected and Zone III has 3.6% less. This is explained by the sudden increase in highly fragmented goose bones in Zone IV.

Unidentified Fragments

Shafts of bones without articular ends were not identifiable. The only exception to this was the bones of loons where the bone is very dense and heavy and the shape flattened. Unidentifiable fragments were counted, however, and whenever possible the element noted. Carpometacarpi, tarsometatarsi, and coracoids were recognisable as such even when they were not identifiable. Damaged vertebrae were often not identifiable. Some medium to small vertebrae were not identified, although technically this would have been possible, and these are included in the fragment totals. All sacrum, sternum, mandible, and skull fragments with sufficient remaining features were attempted, but there were many unidentifiable fragments. Total fragments for each zone are given in Table 9. Zone I had fewer unidentifiable fragments than Zone II and Zone III. Zone IV had the largest number of fragments. The total number of fragments (9078) is about one and a half times the number of identified bones (5966).

Table 9. Unidentified Fragments

	I	II	III	IV	ZU*	
Long Bone Fragments						
Very Large	9	60	48	59	8	
Large	33	467	463	547		
Medium	62	923	1370	1910		
Small	3	111	75	93		
Very Small		1	4	3		
Vertebra Fragments						
Very Large	7	16	88	77		
Large	1	34	38	41		
Medium	3	62	63	164		
Small	1	22	23	30		
Sternum	38	134	210	353		
Sacrum	6	55	178	157		
Rib	4	21	52	152		
Toe	14	110	77	122		
Mandible		2	25	16		
Skull	3	33	35	51		
Coracoid		9	23	40	1	
Carpometacarpus	1	38	40	38	9	
Carpo-ulnae		1	1			
Wing Digit		17	18	18		
Furcula	2	6	4	25		
Scapula			3	3		
Alula & Distal Wing Digit			2	11	1	
Total	187	2122	2840	3910	19	
% of Total	2.1	23.4	31.3	43.1	0.2	
% Identified	36.4	40.3	42.3	36.4		
Grand Total						9078

* Zone unknown.

In an attempt to ascertain the source of the long bone fragments, the condition of all identified bones is summarized in Table 10. When identified bones are almost all complete or when they were broken in halves or thirds, they would have left few unidentifiable fragments. This is the case with coracoids, carpometacarpi, and leg bones except those of the albatross. In addition coracoids and carpometacarpi were generally recognised as such and totaled separately. The wing bones of medium, small, and very small birds were generally relatively short and tended to break only once (if at all) leaving two identifiable ends. This is clearly seen in the small number of small and very small long bone fragments in all zones.

Table 10. Types of Breakage

	Birds in Large Numbers							Birds in Small Numbers			
		Humerus, Radius, Ulna			Carpometacarpus coracoid leg bones, etc.						
		most articular ends	broken or complete	most complete	most articular ends	broken or complete	most complete		most articular ends	broken or complete	most complete
Very Large	Eagle	X					X				
	Albatross	X			X						
	Canada Goose	X				X		Pelican	X		
								Swan	X		
Large	Common Loon		X				X				
	Cormorant			X			X				
	Snow Goose	X					X				
	Raven			X			X				
	Large Gulls		X			X					
								Horned Owl	X		
								Heron	X		
Medium	Crow			X			X				
	Mew Gull		X				X				
	Kittiwake		X				X				
	Common Murre			X			X				
	Arctic Loon			X			X				
	Large Grebes			X			X				
	Scoters		X				X				
	Merganser		X				X				
	Black Brant		X				X				
								Red-throated Loon		X	
								Fulmar			X
Small								Small Grebes		X	
								Ruffed Grouse		X	
								Bonaparte's Gull			X
								Guillemot			X
								Screech Owl			X
								Small Ducks		X	
Very Small								Petrel			X
								Shore Birds			X
								Kingfisher		X	
								Woodpecker			X
								Passerine			X

The very large birds, eagle, albatross, Canada Goose, pelican, and swan, have very long and very lightly built bones. These bones have thin walls with fine struts of bone for strength and are easily crushed. Their articular ends remain in the collection to be identified as articular ends only and the shafts are unidentifiable fragments. Among the large birds the Snow Goose, Horned Owl, and heron also have long, light bones and articular ends only in the collection.

The size of the long bone fragments was judged by their apparent diameter. Since most of these fragments were not complete cylinders, this had to be judged by eye. The humerus in any species is larger in diameter than the ulna, and the radius is much smaller. This means that the radii of very large birds were classified as large or medium. The fragments listed as being very large were, then, mostly humeri of eagle, albatross, and Canada Goose. (The pelican and swan were found in such small numbers that they could have contributed very few fragments.) The large fragments were ulnas of eagle, albatross, and Canada Goose. The medium fragments were radii of the very large birds plus long bones of Snow Geese. In summary, the fragments consisted mostly of shafts of wing bones of geese, eagles, and albatross, all birds of long wings and light, fragile bones.

The surprisingly large number of long bone fragments in Zone IV must be a result of the increase in this zone of the number of geese. Albatross would appear much more heavily in Zone III. There is no indication whether the bones were broken during preparation for cooking or during eating. These excellent flyers have air-filled bones. They would have been of no interest for food, but they were certainly used and broken for material for small bone implements. Splinters of bird bone were used for making awls, needles, gorges for waterfowl capture, and possibly fish-hook points. Cylindrical pieces were used for beads, whistles, and possibly drinking tubes (Dewhirst 1980).

The per cent of total pieces (identified bones plus fragments) identified remains the same from the oldest zone to the newest (36.4-42.3%). This indicates no more crushing of bones occurred at the lowest levels of the midden than at the upper. The smaller number of identified bones (and fragments) in Zone I is an indication of fewer birds taken during that period, rather than that the bones were destroyed in the midden. This could be because of fewer people or discontinuous habitation at the site of the excavation. The capture technology was available because the species composition is the same as that in the other zones. And they were certainly eating birds, though perhaps not as intensively as later.

Methods of Capture and Preparation

The only descriptions of capture methods in actual use at Yuquot are those given in Drucker (1951) for the period 1870 to 1900. He describes simple snares, duck traps, fire-lighted canoes, bows and arrows, and slug slime as methods of bird capture.

Simple snares were reported as being used for eagles (Drucker 1951: 34), but he gives no description of the snare or the method used. He also speaks of a hidden hunter grabbing an eagle by the legs as it landed on the salmon used for bait (Drucker 1951: 59). Sprot (1928: 142) describes a snare from Barkley Sound which was supposed to have been used for shore birds. It consisted of a length of cedar bark braided with dogfish spine every 9 in. A noose of twisted human hair was attached by threads of cedar bark. As very few shore birds were taken at Yuquot (Sprot uses shore birds to mean sandpipers), there is some doubt whether this was used at Yuquot, unless it was perhaps used for gulls.

Two types of traps are described (Drucker 1951: 33-34) as used for diving sea birds. In the first a frame weighted with stones at the corners was dropped in the lower intertidal zone. Salmon eggs were thrown under it. (This indicates fall use. The diving birds would not be attracted to dead bait, but perhaps other types of fish eggs were used in the winter and spring.) Nooses of fine string held open by baleen or quill splints or nooses made of baleen or quill were strung along the lower edge of the frame. Diving birds seeking the eggs were caught by their necks and drowned. The second trap was a pole or rope with attached baited bone gorges. The trap was submerged a foot or two and diving sea birds taking the baits were caught by the gorges lodging in their throats. Drucker does not say how the gorges were baited, but the baits must have been live or appeared live to attract the birds. Perhaps live bait fish were simply held by gorges lodged in their throats or caught into one gill from the throat. The gorges could not be set crosswise into the bait or the bird would not be able to swallow it. This simple trap would be effective during the fall, winter, and spring on all diving sea birds, loons, grebes, cormorants, alcids, and diving ducks. Drucker (1951: 59) speaks of traps set for diving ducks and gulls during the salmon spawning season, but gulls could not be caught with this sort of trap unless it was set very close to the surface, not submerged 1-2 ft. as he originally says.

Fire-lighted canoes were the preferred method of catching geese during the spring migration. Jewett (in Nootka as a prisoner 1802-05) (Pearse 1968: 260-61) said that they

> had plentiful supply of wild geese which were brought us in great quantities by the natives. Maquina informed me (these) were caught with nets made from bark in the fresh water of that country. Those who take them make choice for that purpose of a dark and rainy night, and, with their canoes stuck with lighted torches, proceed with as little

> noise as possible to the place where the geese are collected, who, dazzled by the light, suffer themselves to be approached very near when the net is thrown over them and in this summer from 50 to 60 or even more will sometimes be taken at one time.

Drucker (1951: 42-43) says that the geese ("migratory waterfowl") came into the heads of the inlets and deep sheltered bays when the weather was stormy.

> Two men went in a canoe, one to manage the net and the other to paddle. A board covered with sand was laid across the gunwales behind the steersman and a fire was kindled on it. The steersman had a section of cedar-bark mat with a rod bound to one end to hold it flat. He held the rod in his teeth so that the mat hung before him, shading the bow of the canoe. As the canoe approached a flock of waterfowl, the birds were disturbed by the light, and sought the patch of shadow cast by the mat in front of the canoe. They would do this only on black stormy nights, when there was not a glimmer of moonlight or starlight to reveal the canoe.
>
> On nearing the quarry, the steersman paddled very slowly and quietly. Often he laid his paddle, which was tied to the thwart by a long cord, in the water, drifting in the last few yards so that he could use his hands to manipulate the mat. When the birds had gathered in a small space before the canoe, the man in the bow cast his net over them. It was but a moment's work to wring the necks protruding through the net. With proper weather conditions and skillful management of the mat, a canoe could be filled with ducks, geese, and even swans in a short time.

The net used was a rectangle of large mesh hung by loops on two 6-ft. long horizontal poles, one top and one bottom, both fixed to a 12-ft. long carrying pole by their centres. Where this would be a very efficient method of taking geese, non-diving ducks, and even swans as Drucker says, I am not certain that diving ducks could be taken by this method. It is interesting that Jewitt mentions only geese in this connection, although he errs in speaking of summer as the time of capture. There would be no large flocks of geese in summer. This method could, of course, be used on wintering flocks in the same way. This method was in effective use during the historic period, as the quotations above show, and numbers of geese were caught by it. But it does not explain the sudden increase in the numbers of geese taken in the historic period compared with the earlier periods.

Bows and arrows were used from canoes (Drucker 1951: 43) when the nights were not stormy enough to drive waterfowl into the inlets. A screen of fir branches was put around the canoe to hide the occupants and the canoe paddled slowly out to the flocks of diving ducks gathered just outside the breakers. The ducks were then shot with arrows or in historic times with guns. Geese and other water birds would have been caught by this method also. Martinez (Pearse 1968: 138) in 1789 said the natives were still using bows and arrows "to hunt all kinds of birds." Eagles were also shot with arrows (Drucker 1951: 59).

Hummingbirds were taken with slug slime placed on small twigs near flowering plants. They landed on the twigs and their feet became

entangled in the slime. These birds were used as playthings for children with strings tied through their nostrils (Drucker 1951: 451). They were also sold to visiting ships (Journals of Captain James Cook 1967: 1350).

These described methods adequately explain capture of eagles (arrows, snares), diving sea birds (traps, arrows from canoes), and geese (arrows from canoes, fire-lighted canoes). Nothing is said of the capture of the remaining beach scavengers, the crow, raven, and gulls. These could all have been taken with bows and arrows, baited snares, baited gorges set on the beach, or stones. And no mention is made of the capture, or even presence of, the albatross which so dominate the midden. They would have disappeared between 1887 and 1929 when the population had been reduced to less than 2000 birds at the breeding islands (near Japan). Both Miller (1940: 231) and Martin and Myres (1969: 246) describe albatross approaching boats out of curiosity during late summer. Langsdorff (Pearse 1968: 102) speaks of Aleutian island natives clubbing them from canoes when they cannot take off from the sea due to lack of wind. They could also be easily caught with baited hooks or gorges from canoes.

Drucker (1951) also does not mention birds killed with stones or dead or injured birds picked up on the beach either for meat or for feathers. Both of these methods of capture are certainly probable.

The large flight nets for migrating waterfowl (Sprot 1928: 139) in Washington State and at Chemainus on the southeast side of Vancouver Island were not used at Yuquot. Perhaps there were no wide beaches in the usual flight paths of the geese.

Methods of preparation are not indicated by the bones. Only a very few showed any direct contact with fire. A very few (a pelagic cormorant ulna from Zone III, an arctic loon ulna, an albatross tibiotarsus from Zone III and three from Zone II, two albatross femurs from Zone III and three from Zone IV, and six proximal and three distal albatross ulnas) had cutting marks near joints, but not in any consistent pattern. These marks were made with sandstone abrasive saws, except those in Zone IV, which could have been made with knives. Many bones appeared to have been deliberately broken, as shown by spiral fracturing. Drucker (1951: 62) says that birds were boiled, but he does not give any information on how they were prepared for boiling. The boiling water was little used, but the fat was highly valued. He mentions (Drucker 1951: 63) the oily skins of ducks and geese, but all sea birds are fat, and the albatross very fat. The flesh of birds was used fresh and never dried for storage (Drucker 1951: 65). Tabus were applied to the flesh of crows and ravens (Drucker 1951: 61), which makes their constant small numbers in the midden difficult to explain. Some may have been captives, some died on the midden. Were the others killed, but not eaten? Gulls were avoided by young adults because of an association of these birds with twinning, but older people ate them. Gull eggs were not eaten until historic times, when their use was learned from the Haida and Tsimshian (Drucker 1951: 61).

Grams of Food

The traditional method of calculating the weight of edible material of a bird, muscle meat, heart, and liver, is to use 70% of the live weight (White 1953: 398). This is a measure derived roughly from domestic birds and not tested on wild birds. A recent note (Stewart and Stahl 1977: 269) gives actual figures for edible meat for two birds, a hawk and a crow, at about 35%. Between 35 and 50% would be a much more realistic figure, but we have used the 70% figure until more information on different types of birds is available. Albatross, for instance, have light bones but very long wings which are intended for gliding and very lightly muscled compared to those of geese. Loons, on the other hand, are well muscled, but have very heavy bones. Because of the use of 70% of the live weight, the total weights of avian food for the zones may be as much as double those actually available to the eaters.

The live weights themselves are a source of difficulties. In the first place very few are published, and there is seldom any mention of the season or condition of the birds. There is considerable variation between sexes, ages, individuals, and variation in any one individual during different seasons. The weights used here were taken primarily from Palmer (1962). Male and female weights were averaged. Weights of a few smaller birds were taken from Stewart and Skinner (1967: 37-42) and from White (1953: 398). Weights were not available for the Eared Grebe, Ruffed Grouse, crow, and alcids, and these were estimated. Very small birds were given a meat weight of 0.1 kg, the smallest weight used. In some cases this was an overestimate, but the number of birds was so small that this did not affect the final figures. All weights were shown in kilograms. This was as fine as the crudeness of the live weight data would allow. Crows and ravens were supposedly not eaten (Drucker 1951: 61), but they are included as meat because they are found in the midden.

Table 11 shows weights and zone weights for all species. Table 12 summarizes the data for the main food species with percentages of the zone totals. The composition of the avian food is remarkably similar from zone to zone, even in the oldest zone (Zone I) where bird remains were few. The crows, ravens, and grebes contributed consistently small amounts of food, the eagle slightly more, especially in Zone IV. Gulls, murres, and diving ducks were next being small species but caught in reasonably large numbers. Cormorants were consistently more important because they are larger. Geese provide a consistent 13-16% of the avian food material until the historic period where their contribution more contribution more than doubles to 38%. The albatross is the biggest single contributor, 20-32% until the historic period when it drops to 16% partly because of its own population failure and partly because of increase in the use of geese. Other species are a constant 9-13% until the historic period when they too drop to half their former contribution. During the historic period when geese replaced albatross and some of the species caught in small numbers, catches of scavengers

and diving sea birds continued to be as important in the diet as they had been earlier. Actually, since albatross were caught in the summer and geese largely in the spring (possibly in the fall also), they must have eaten more bird flesh in the spring and considerably less in the summer than they had in prehistoric times.

Table 11. Kilograms of Meat from Each Zone

	Live Wt.	Kg Meat/Bird (70% Wt.)	Kg Meat/Zone I	II	III	IV	
Birds Found in Large Numbers							
Bald Eagle	4.3	3.0	3.0	6.0	6.0	12.0	
Northwestern Crow	0.6	0.4	0.4	2.4	0.8	1.6	
Raven	1.0	0.7	0.7	2.8	2.1	1.4	
Large Gulls	1.2	0.8	1.6	8.8	14.4	9.6	
Mew Gull	0.5	0.4	0.4	3.2	4.0	2.8	
Kittiwake	0.4	0.3	0	0.9	1.5	0.6	
Common Murre	1.0	0.7	1.4	7.7	17.5	5.6	
Marbled Murrelet	0.5	0.4	0	1.2	2.4	1.6	
Double-crested Cormorant	1.8	1.3	1.3	9.1	3.9	8.5	
Brandt's Cormorant	2.0	1.4	1.4	5.6	8.4	9.8	
Pelagic Cormorant	1.9	1.3	1.3	5.2	3.9	9.1	
Common Loon	3.4	2.4	2.4	7.2	7.2	4.8	
Arctic Loon	1.9	1.3	1.3	6.5	7.8	14.3	
Red-necked Grebe	1.1	0.8	0	1.6	1.6	1.6	
Western Grebe	1.5	1.1	0	1.1	2.2	2.2	
Surf, Common Scoter	1.0	0.7	0.7	4.9	6.3	7.7	
White-winged Scoter	1.4	1.0	1.0	3.0	3.0	5.0	
American Merganser	1.3	0.9	0.9	2.7	2.7	6.3	
Canada Goose	3.6	2.5	2.5	25.0	17.5	57.5	
Snow Goose	2.6	1.8	1.8	5.4	12.6	34.2	
Black Brant	1.4	1.0	0	1.0	4.0	8.0	
Short-tailed Albatross	3.1	2.2	6.6	63.8	66.0	41.8	
Shearwater	0.8	0.6	0.6	4.2	1.8	1.2	
Birds Found in Small Numbers							
Red-throated Loon	1.8	1.3	1.3	1.3	2.6	1.3	
Eared Grebe	0.3	0.2	0	0.2	0.2	0	
Horned Grebe	0.5	0.4	0	0	0.4	0	
Pied-billed Grebe	0.2	0.1	0	0	0	0.1	
Fulmar	0.7	0.5	0	1.0	1.0	0.5	
Fork-tailed Petrel	0.1	0.1	0	0.2	0.1	0.2	
Brown Pelican	3.5	2.5	0	0	2.5	0	
Great Blue Heron	3.0	2.1	2.1	2.1	2.1	2.1	
Whistling Swan	6.7	4.7	0	4.7	0	0	
White-fronted Goose	2.2	1.5	0	1.5	1.5	1.5	
Mallard	1.2	0.8	0	0.8	0.8	0.8	
Pintail	0.9	0.6	0.6	0	0.6	0.6	
Green-winged Teal	0.4	0.3	0	0	0.3	0	
American Widgeon	0.7	0.5	0	0.5	0	0	
Scaup	0.9	0.6	0	1.2	1.2	1.2	
Goldeneye	0.9	0.6	0	1.2	0.6	0.6	
Bufflehead	0.4	0.3	0	0.6	0	0.9	
Old Squaw	0.9	0.6	0	0.6	0.6	0	
Peregrine	0.6	0.4	0	0.4	0.4	0	
Sparrow Hawk	0.1	0.1	0	0.2	0.1	0	
Sora	0.1	0.1	0	0	0.1	0	
Ruffed Grouse	1.0	0.7	0	1.4	0	1.4	
Killdeer	0.1	0.1	0	0	0	0.1	
Greater Yellowlegs	0.2	0.1	0	0	0	0.1	
Dowitcher	0.2	0.1	0	0	0	0.1	
Black Turnstone	0.2	0.1	0	0	0	0.2	
Sanderling	0.1	0.1	0	0.1	0	0	
Bonaparte's Gull	0.3	0.2	0.2	0	0.2	0	
Pigeon Guillemot	1.0	0.7		0.7	0.7	0	
Tufted Puffin	1.4	1.0	0	0	1.0	0	
Rhinoceros Auklet	1.0	0.7	0	0	1.4	0.7	
Cassin's Auklet	0.1	0.1	0.1	0.1	0	0.1	
Screech Owl	0.1	0.1	0	0.1	0.1	0	
Great Horned Owl	1.5	1.1	0	1.1	0	0	
Saw-whet Owl	0.1	0.1	0	0	0.1	0	
Snowy Owl	1.5	1.1	0	1.1	0	0	
Belted Kingfisher	0.2	0.1	0	0.4	0.1	0	
Red-shafted Flicker	0.2	0.1	0	0.1	0	0	
Yellow-bellied Sapsucker	0.1	0.1	0	0.1	0.1	0	
Horned Lark	0.1	0.1	0	0	0.1	0	
Steller's Jay	0.2	0.1	0.1	0.2	0.2	0	
Robin	0.1	0.1	0	0.1	0.1	0.1	
Red-winged Blackbird	0.1	0.1	0	0.3	0.1	0.2	
Fox Sparrow	0.1	0.1	0	0.1	0	0	
Total Meat/Zone (kg)			33.7	201.7	216.9	260.0	712.3
% in Each Zone			4.7	28.3	30.5	36.5	

Table 12. Kilograms of Meat for Main Food Species. % of Zone Total in Parentheses

	I	II	III	IV
Bald Eagle	3.0 (9)	6.0 (3)	6.0 (3)	12.0 (5)
Northwestern Crow	0.4 (1)	2.4 (1)	0.8 (0)	1.6 (1)
Raven	0.7 (2)	2.8 (1)	2.1 (1)	1.4 (1)
Gulls	2.0 (6)	12.9 (6)	19.9 (9)	13.0 (5)
Common Murre	1.4 (4)	7.7 (4)	17.5 (8)	5.6 (2)
Cormorants	4.0 (12)	19.9 (10)	16.2 (8)	27.4 (11)
Loons	3.7 (11)	12.7 (6)	15.0 (7)	19.1 (7)
Grebes	0	2.7 (1)	3.8 (2)	3.8 (2)
Diving Ducks	2.6 (8)	10.6 (5)	12.0 (6)	19.0 (7)
Geese	4.3 (13)	31.4 (16)	34.1 (16)	99.7 (38)
Albatross	6.6 (20)	63.8 (32)	66.0 (30)	41.8 (16)
Other Species	4.4 (13)	22.4 (11)	19.3 (9)	12.8 (5)

Anterior Versus Posterior Bones

It was stated earlier that there were very few leg bones in the gulls. Percentages were calculated to compare this situation in gulls with that in other main food species (Table 13). Frequencies of six anterior bones were counted: coracoid, humerus, radius, ulna, carpometacarpus, and wing digit. The sum of these was compared with the sum of frequencies of the three leg bones: femur, tibiotarsus, and tarsometatarsus. The normal intact bird would have 66% wing bones and 33% leg bones. The albatross and eagle are extremely close to these ideal percentages. In other words, the whole carcass came to the midden. These are also very large birds, and perhaps the large pieces of meat were removed from the carcass and the whole skeleton thrown on the midden. This is particularly evident in the albatross where there are also unusually high numbers of toes and vertebrae in the collection. The oily skins and the feathers (particularly of the eagle) would, of course, have been used also.

Grebes and cormorants were close to the ideal percentages, showing that there was little loss of legs before the skeleton reached the midden. The crows for some reason had slightly too many legs, but this may be an accident of the small numbers involved.

Among the remaining groups there is a progressive increase in the number of missing legs. Loss of these elements could not be attributed to their more fragile nature because in all these groups leg bones are at least as strong as wing bones and usually stronger. There is also no correlation with method or place of capture, size, or relative amount of meat on the legs. Murres and diving ducks are caught in the same manner as grebes, and have a similar distribution of meat. In the diving ducks and murres some legs were discarded before reaching the midden, in geese more, and in gulls almost all. This indicates that gulls at least and some geese, ducks, and murres were cleaned on the beach and the legs discarded there. Why there should be this difference in treatment is not clear.

Table 13. Anterior Versus Posterior Bones

	Sum of 6 Wing Bones	Wing as % of Wing & Leg Bones	Sum of 3 Leg Bones	Leg as % of Wing & Leg Bones
Normal				
Intact Bird		66		33
Close to Normal				
Albatross	519	66	263	34
Eagle	34	65	18	35
Grebes	40	63	23	37
Cormorants	259	62	161	38
Too Many Legs				
Crow	65	57	50	43
Too Many Wings				
Loons	138	70	59	30
Ravens	59	71	24	29
Diving Ducks	336	77	100	23
Common Murre	347	78	98	22
Geese	432	82	102	18
Gulls	425	87	65	13

Seasonality

Seasonality of the main food species (bones found in large numbers) is summarized in Fig. 9. The Bald Eagle, Northwestern Crow, Raven, Glaucous-winged Gull, all beach scavengers, and the Common Murre, Murrelet, and Pelagic Cormorant, diving sea birds and fish-eaters, were all available as food species year-round.

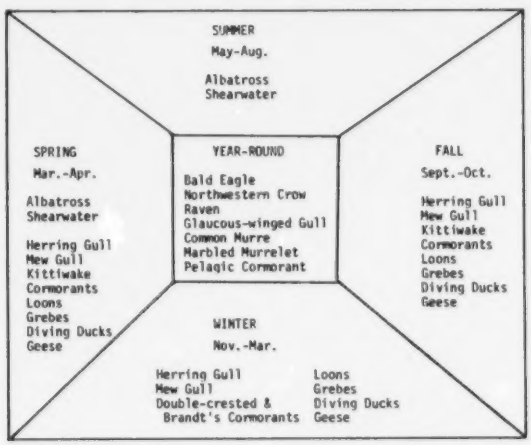


Fig. 9. Seasonal availability of avian species. Yuquot site presumably occupied from February to October during Zones I-III.

Most sea birds of the west coast are winter residents, nesting in the interior of the province and returning to the coast in late September and October. These include Herring and Mew Gulls among the scavengers, Double-crested and Brandt's Cormorants and loons and grebes among the diving sea birds, and diving ducks and geese. Some of these migrate through the Yuquot area to more southern wintering grounds, but large numbers of all the diving birds and diving ducks remain through the winter and early spring until the ice goes out on inland lakes usually in April. When the sea is rough they move into sheltered coves and inlets, and there they could probably not be reached by canoe. The Kittiwake is a common migrant, away in winter, but the other gulls stayed all winter.

There is no evidence in the bones themselves to indicate at what season the birds were caught. Snare traps baited with salmon eggs indicate a fall capture time, when salmon eggs could be stripped from ripe females. The "moon of the geese" designated the month in the spring (usually April) (Drucker 1951: 116) when geese returned on migration. This followed the time of the herring spawn and was eagerly

awaited, which is an indication that geese were not available in any numbers in the winter.

Except for a few non-breeding loons and breeding Canada Geese and American Mergansers, the loons, grebes, diving ducks, and geese disappeared to their interior breeding grounds after the spring migration. They were replaced by albatross. Albatross are summer visitors appearing in small numbers in the spring and becoming more numerous and more attracted to boats in the summer. They and the shearwaters leave for distant breeding grounds in early fall. Their appearance in the midden in large numbers indicates active hunting during late summer.

Marine Nature of the Fauna

The orientation of bird hunting at Yuquot was towards the sea, especially towards the commoner and larger marine species. Of the 67 species of birds recovered from the midden, 23 (34%) were found in numbers greater than 22 bones and were considered the major food species. Of these, all were marine species while at Yuquot. The three gulls, eagle, crow, and raven are marine scavengers. The eagle was taken on the beach. The others could be taken on the beach or attracted with garbage into the village. The albatross and shearwater are marine scavengers attracted by bait to boats. The 12 diving birds (two alcids, three cormorants, two loons, two grebes, and three diving ducks) were all taken in the water itself, with fish-baited gorges, snare traps, or bows and arrows. The geese were taken either with throw nets from fire-lighted canoes or with bows and arrows.

Of the 44 species (66%) found in smaller numbers, 22 (33%) are marine and would have been caught with the regular food species. An additional nine (heron, kingfisher, Horned Lark, Snowy Owl, and five sandpipers) came from the beach or possibly the marsh. The lark and the owl are not beach species during the breeding season, but they frequent high, dry sections of beaches in the non-breeding season. This leaves only 12 non-marine species. The Red-winged Blackbird and Sora come from the marsh and the Robin, Sparrow Hawk, Flicker, and Steller's Jay from open spaces near the village. The Fox Sparrow, grouse, sapsucker and three owls were from the forest.

Therefore, only 12 (18%) of the total species were non-marine and only six of these (9.4%) were forest birds. Only 71 (1.2%) of the total bones found in the midden and 26 (4.3%) of the minimum number of individuals were non-marine. Only 30 (0.5%) of the total bones and 11 (1.8%) of the minimum number of individuals were forest species.

This almost exclusive marine orientation runs through all the archaeological zones. Although there are very few bird bones in the earliest zone, they are of similar constitution to those in the later ones. The Indians must have been marine oriented when they first occupied the site more than 4000 years ago. The only major cultural changes shown by the avian data are the increase in the use of geese and the decrease in use of albatross, both in the historic period.

Conclusions

Of the 67 species found in the midden, 23 were found in numbers over 22 and were major food species. The beach scavengers, Bald Eagle, Raven, and Northwestern Crow, and the loons and grebes among the diving sea birds, were taken in moderate numbers. Gulls, cormorants, and diving ducks were staples, the cormorants producing a disproportionate percentage of the meat because they are larger. Geese were of no more importance than the others until the historic period, when they doubled in numbers and meat percentage to 38% of the meat for the zone.

The diving birds maintained their importance during this time. The Short-tailed Albatross, which is nearly extinct now, was the only species of albatross taken. It was presumably hunted close in shore where there are no albatrosses now. It was taken in large numbers and represented a large amount of the meat (30%) for Zones II and III. During the historic period its use dropped to half the previous amount.

The birds found in smaller numbers were almost all sea or beach birds. These species were mostly smaller or rarer birds which were caught on the beach or sea surface with the regular food species. Thus all available medium- to large-sized sea birds were taken. Very few incursions were made into the dense forest for birds. There were some smaller passerines, sandpipers, woodpeckers, and kingfishers probably taken by children or for their coloured feathers. A very few larger, rarer owls, hawks, herons, and a swan and a pelican were taken, the last two probably with the regular food species.

Fragments were mostly wing bone shafts of the larger birds, geese, albatross, and eagle. Sixty per cent of the avian bone pieces found in the midden were unidentifiable fragments. Fragments were used in the manufacture of various bone points and small implements.

Because of the migratory patterns of the birds, bird hunting was seasonal. Albatross were taken in the summer, caught when they could not take off in calm weather or attracted to canoes with baited hooks or gorges. Geese were captured from fire-lighted canoes or with bows and arrows during the spring migration. Some could also have been taken in the fall. Diving birds were caught in submerged traps employing snares or baited gorges during the fall and possibly winter and spring. Gulls were caught in similar traps set at the surface or on the beach. Eagles were snared or shot on the beach and both eaten and used for feathers for ceremonial purposes. There was a tabu on the eating of crows and ravens, but they do appear in small numbers in the midden. Crows and gulls were kept as free-flying pets.

References Cited

Aish, P.J., J.T. Dewhirst, and W.J. Folan. 1968. Dry-cleaning Tags in the Archaeological Laboratory. American Antiquity, Vol. 33, No. 4, pp. 504-5. Washington, D.C.

Alexander, W.B. 1955. Birds of the Ocean. Putnam, London.

Dewhirst, John. 1977. The Origins of Nootkan Whaling: a Definition of Northern and Central Nootkan Ecological Orientation for the Past Four Millenia. Paper presented at the Canadian Archaeological Association Tenth Annual Meeting, 5-8 May 1977, Ottawa.

---. 1978. Nootka Sound: a 4,000 Year Perspective. nu·tka· The History and Survival of Nootkan Culture. Sound Heritage. Vol. 7, No. 2, pp. 1-29. Victoria.

---. 1980. The Indigenous Archaeology of Yuquot, a Nootkan Outside Village. National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, No. 39, The Yuquot Project, Vol. 1.)

Drucker, P. 1951. The Northern and Central Nootkan Tribes. Smithsonian Institution Bureau of American Ethnology Bulletin 144. Washington.

Edwards, R.Y. 1968. Notes on the Gulls of Southwestern British Columbia. Syesis, Vol. 1, pp. 199-202. Victoria.

Folan, William J. and John T. Dewhirst. 1970. Yuquot: Where the Wind Blows from All Directions. Archaeology, Vol. 24, No. 4, pp. 276-86.

Godfrey, W. Earl. 1966. Birds of Canada. National Museum of Canada Bulletin 203, Biological Series, No. 73. Queen's Printer, Ottawa.

Guiguet, C.J. 1971. A List of Seabird Nesting Sites in Barkley Sound, British Columbia. Syesis, Vol. 4, pp. 252-59. Victoria.

Journals of Captain James Cook. 1967. Vol. 3, The Voyage of the Resolution and Discovery, 1776-1780. Part 2. ed. J.C. Beaglehole. Hakluyt Society, Cambridge. Vol. 2, A Voyage to the Pacific Ocean. H. Hughs, London.

Kortright, Francis H. 1953. The Ducks, Geese, and Swans of North America. Stackpole Co., Harrisburg, Pennsylvania.

Martin, P.W. and M.T. Myres. 1969. Observations on the Distribution and Migration of Some Seabirds off the Outer Coasts of British Columbia and Washington State, 1946-1949. Syesis, Vol. 2, pp. 242-56. Victoria.

Miller, Loye. 1936. Some Maritime Birds Observed off San Diego, California. Condor, Vol. 38, No. 1, pp. 9-16. Hollywood, California.

---. 1940. Observations of the Black-footed Albatross. Condor, Vol. 42, No. 5, pp. 229-38. Hollywood, California.

---. 1960. Some Indian Midden Birds From the Puget Sound Area. Wilson Bulletin, Vol. 72, No. 4, pp. 392-97. Kalamazoo, Michigan.

Moziño, José Mariano. 1970. Noticias de Nutka. An Account of Nootka Sound in 1792. Translated and edited by Iris Higbie Wilson. University of Washington Press, Seattle.

Munro, J.A. and I. McTaggart Cowan. 1947. A Review of the Bird Fauna of British Columbia. British Columbia Provincial Museum Special Publication 2. Victoria.

Palmer, R.S. 1962. Handbook of North American Birds. Yale University Press, New Haven.

Pearse, T. 1968. Birds of the Early Explorers in the Northern Pacific. The Close, Comox, British Columbia.

Smith, Ian. 1973. The Unknown Island. J.J. Douglas Ltd., West Vancouver.

Sprot, G.D. 1928. The Early Indian Wildfowler of Vancouver Island. Canadian Field-Naturalist, Vol. 42, No. 6, pp. 139-43. Ottawa.

Stewart, J.L. and P.W. Stahl. 1977. Cautionary Note on Edible Meat Poundage Figures. American Antiquity, Vol. 42, No. 2, pp. 267-70. Washington, D.C.

Stewart, P.A. and R.W. Skinner. 1967. Weights of Birds from Alabama and North Carolina. Wilson Bulletin, Vol. 79, No. 1, pp. 37-42. Kalamazoo, Michigan.

Swarth, H.S. 1912. A Visit to Nootka Sound. Condor, Vol. 14, No. 1, pp. 15-21. Hollywood, California.

White, T.E. 1953. A Method of Calculating the Dietary Percentage of Various Food Animals Utilized by Aboriginal Peoples. American Antiquity, Vol. 18, pp. 396-98. Washington, D.C.

Yesner, D.R. 1976. Aleutian Island Albatrosses: A Population History. Auk, Vol. 93, No. 2, pp. 263-80. Laurence, Kansas.

Osteology of the Human Remains from Yuquot, British Columbia

Jerome S. Cybulski

176 Abstract
177 Acknowledgements
178 Introduction
179 Demographic Aspects
183 Cranial Morphology
187 Postcranial Morphology
188 Dentition
190 Skeletal Pathology
191 Summary
193 References Cited

Abstract

Osteological data are presented for human remains recovered from a large midden deposit at Yuquot, British Columbia, a village of the Moachat Nootkans. The skeletal sample is small and the remains are fragmentary. Observations on cranial and postcranial morphology, incidence of dental pathology, and instances of skeletal pathology are presented.

Submitted for publication 1972, by Jerome S. Cybulski, Archaeological Survey of Canada, National Museum of Man, Ottawa.

Acknowledgements

I would like to thank Dr. William J. Folan for inviting me to participate in the Yuquot Project and for entrusting me with the analysis of the skeletal remains. Ms. Gloria Moy very ably assisted in sorting and identifying the bone fragments.

Introduction

The skeletal remains considered in this report were recovered in 1966 during excavation of a large midden deposit at the Moachat Nootkan village of Yuquot, located on Nootka Sound on the west coast of Vancouver Island, British Columbia. The excavation was directed by William J. Folan for the National Historic Parks and Sites Branch. Preliminary reports of the excavation, which has come to be known as the Yuquot Project, have been published (Folan 1969; Dewhirst 1969; Folan and Dewhirst 1970).

The excavated portion of the Yuquot midden was a trench about 64 ft. long, 10 ft. wide, and 18 ft. deep. Archaeological assessment suggests that the deposit reflects continuous occupation of the area for more than 4000 years (Dewhirst 1980).

Human remains were concentrated in the upper and middle strata of the deposit. They largely represent scattered and isolated fragments. In no case was there a complete or nearly complete skeleton. The total collection, as received in the laboratory, consisted of approximately 200 cranial and postcranial bone fragments and 100 teeth. The remains were poorly preserved and suffered considerable postmortem damage. Only a few complete bones were present.

Indications are that most of the material, including three designated "burials," is of early historic affiliation. Some scattered remains were found in the prehistoric levels, but the few obtainable osteological data do not permit an analytical separation of the skeletal materials into two temporal components. The materials have, therefore, been treated as a unit in this report. This is not to imply that the remains represent a viable population unit. To the contrary, there is evidence, discussed later, to suspect that the remains do not constitute those of a homogeneous sample. This information, together with the fact that the scant data do not allow statistical assessment, limits the present study to a largely descriptive rather than inferential analysis. Morphological observations and measurements of the cranial and postcranial remains, observations on teeth, and instances of skeletal pathology are included.

Demographic Aspects

Following are brief descriptions of three "burials," designated so in the field, along with an estimate of the number of individuals, age, and sex represented by all the skeletal remains in the collection. The three "burials" were located at 6 in.-3 ft. below the surface of the deposit.

Burial 1T1A2

Burial 1T1A2, designated Burial 1 in the field, included an adult female skull and a humerus. Whether the skull and humerus are of the same individual cannot be determined with certainty, but the general morphology of the humerus is suggestive of a female. The skull was crushed and incomplete. It includes the frontal and both parietal bones, the right zygomatic bone, maxilla, portions of both temporal bones, and parts of the sphenoid bone. The mandible and most of the occipital bone are missing. Adult status was determined from evidence of eruption of the third molars and closure of the sphenoccipital synchondrosis. Female characteristics include sharp-edged superior orbital margins, small mastoid processes, and a lack of supraorbital ridge development. The skull had been artificially deformed by means of antero-posterior pressure (Fig. 1). The frontal bone and the lambda region of the parietal bones are flattened and the lateral parts of the cranium are expanded.

Burial 1T1C6

This designated burial (Burial 2) consisted of only a skull. The skull was crushed and most of the right side of the neurocranium had disintegrated. It was possible in the laboratory to reconstruct the remainder of the cranial vault and the facial skeleton. As in the previous case, the mandible is missing. The skull appears to be fully developed and is probably that of an adult female. Age and sex characteristics are similar to those described above. In this case, however, only one of the third molars had erupted. The skull had been artificially deformed in annular fashion (Fig. 2). It is elongated and, when viewed from above, resembles an ellipsoid. There is no evidence of frontal flattening.

Burial 1T1C6/1T1C7

Burial 3 was situated in proximity to Burial 2. It consisted of a

fragmented skull (without mandible) and several disarticulated postcranial bones. The latter include three humeri (two right and one left), a left femur shaft, a right clavicle, a fragment of right scapula, a right radius, a right ulna, five rib fragments, four right metacarpals, one right carpal, and a proximal hand phalange. All remains are adult in development. At least two individuals are represented in the postcranial bones and one or more of the bones may be part of the individual depicted by the Burial 2 skull.

Only the frontal bone and facial skeleton could be reconstructed. The superior orbital margins are rounded, a male characteristic, but the frontal bone lacks supraorbital ridge development, a feature usually

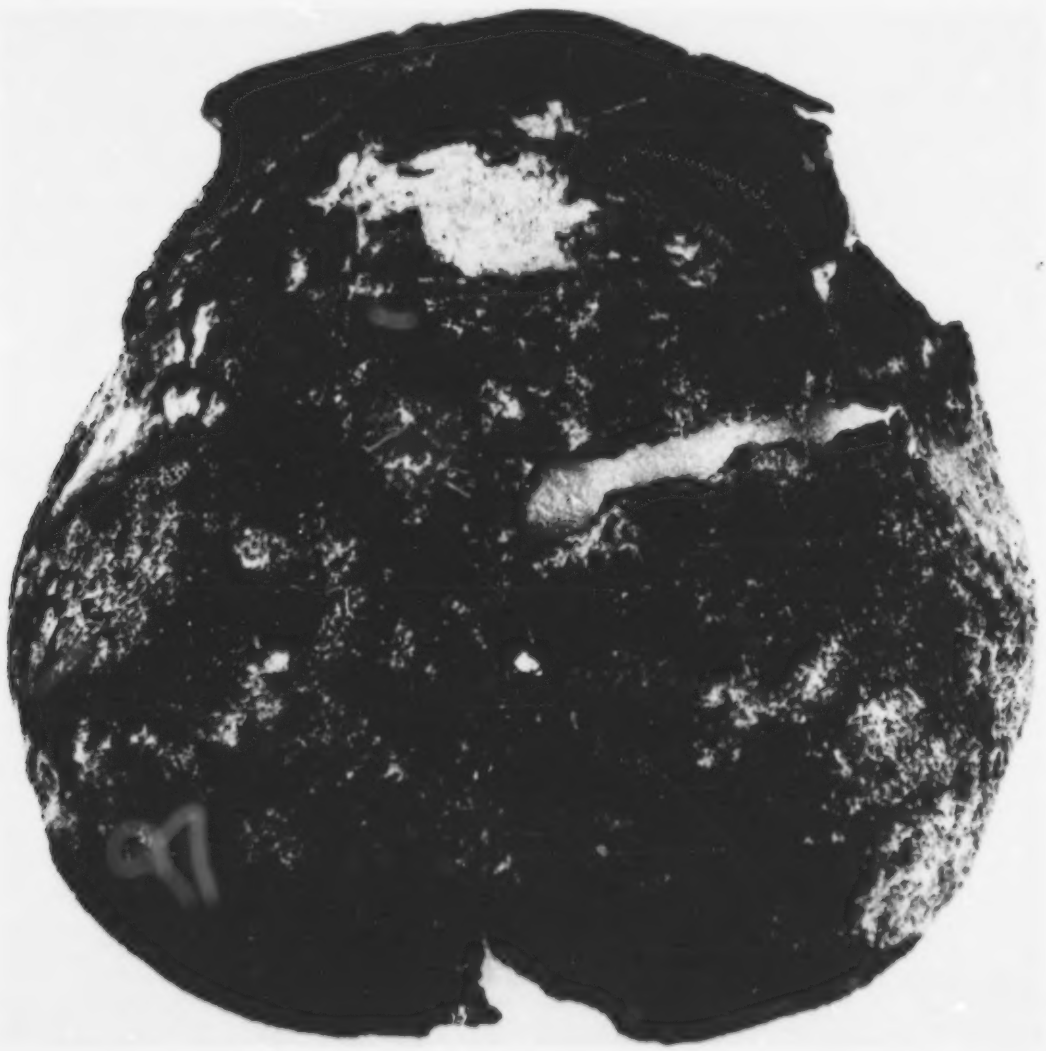


Fig. 1. Superior view of Burial 1T1A2 skull with antero-posterior deformation. (Fig. 1-3: all photos by J. Glover.)

indicative of a female. The limited and conflicting criteria thus preclude a positive sex identification. Due to the incomplete and fragmented nature of the cranial vault, it is not possible to determine whether the skull had been deformed.

In addition to the three adults depicted by the materials described as burials, the complement of other bone fragments distributed in the midden suggests representation of at least three adults and three children. The presence of three children was deduced primarily from skull fragments and, in particular, from maxillary fragments with mixed

Fig. 2. Left-side view of Burial 1T1C6 skull with annular deformation.

dentition (either present or inferred from sockets). Dental development in two left maxillae (1T2G9 and 1T2E13) is commensurate with an age of 6 years, and that of an incomplete right maxilla (1T1A18) gives an age estimate of 7-9 years. In addition to the two adult females described as burials, there would appear to be two adult males in the collection. This is suggested by three temporal bones, two of the right side (1T2C17B and 1T3C17B) and one of the left side (1T3B15), which feature large mastoid processes. In sum, at least nine individuals are indicated in the Yuquot collection. There is, however, no single bone of the skeleton that can clearly be said to represent nine separate people.

Cranial Morphology

An important feature in the cranial morphology of the Yuquot remains is to be found in the skulls of Burials 1T1A2 and 1T1C6. The distinctive element is that both skulls are artificially deformed and, moreover, that the two skulls are deformed differently. Head deformation was widely practiced by the earlier peoples of the southern Northwest Coast, but there were ethnically specific differences in mode of deformation (Boas 1889, 1891). The annular deformation exhibited in Burial 1T1C6 is not unexpected as it is of the form that was generally practiced by the early Northern and Central Nootkan groups (Drucker 1951: 122) of which the Yuquot area is representative. The growth of an infant's head was mechanically restricted laterally and superiorly, but not in length, to produce an adult head form that was elongated and narrow.

The antero-posterior deformation exhibited in Burial 1T1A2 was not practiced by the Nootka of Vancouver Island. It may have been practiced by the Makah Nootka of Washington (Drucker 1951: 122), but mechanical suppression of head growth in length, with a compensating increase in breadth, was a technique principally used by the Coast Salish peoples (Boas 1891; Barnett 1955: 75).

This brief discourse on artificial cranial deformation is important in two respects. First of all, the fact of deformation places certain limitations on morphological inferences of a biological nature from the Yuquot cranial materials. This is particularly true of measurement data. Secondly, the presence of a deformation type that is foreign to the Nootka region under discussion suggests that skeletal materials in the Yuquot midden do not represent a singular population. It is conceivable that the Burial 1T1A2 skull may be that of a slave or possibly a trophy skull. In any case, it should be recognized that description of population characteristics of morphology is severely limited by the skeletal materials at hand.

In describing the morphological data that could be extracted from the Yuquot remains, reference will be made to a previous study of early historic Northwest Coast skulls which I conducted (Cybulski 1972). This study included 56 Nootka crania of both sexes from Vancouver Island, 68% of which were annularly deformed, and 59 Coast Salish crania from Vancouver Island, 80.4% of which were deformed in antero-posterior fashion. A series of annularly deformed Southern Kwakiutl crania was also considered, as well as a series of undeformed Haida skulls. Both interlocal and interethnic group variability were revealed in this analysis. However, only general comparative references will be made in the following discussion as a detailed assessment of the Yuquot collection is not warranted at this time, given its decidedly less than adequate representation as a population.

Measurements

Several measurements were possible on the skulls of Burials 1T1A2, 1T1C6, and 1T1C6/1T1C7. These are recorded in Table 1; the techniques used are described by Montagu (1960: 601-6). The data should be regarded in light of the deformed nature of the skulls as most, if not all, cranial measurements are known to be altered by deformation. In this respect, the absolute dimensions are generally in keeping with measurement results obtained previously for Vancouver Island crania subjected to annular or antero-posterior deformation.

There are only three measurements that allow comparisons of all three skulls. Minimum frontal breadth is identical in 1T1A2 and 1T1C6/1T1C7, but narrower in 1T1C6. The three skulls are similar in alveolar length, but variable in alveolar breadth. This latter feature is emphasized in the maxillo-alveolar indices. The minimum index of 109.3 for 1T1A2 is within the dolichuranic category of description, which denotes a long and narrow maxillary alveolar outline. Both of the other indices are brachyuranic (short and broad), but they are widely different numerically. The overall range of the three values is quite large and indicates considerable variation in this sample.

Table 1. Adult Cranial Measurements and Indices (mm)

Burial	1T1A2	1T1C6	1T1C6/1T1C7
Sex	Female	Female	?
Deformation	Antero-posterior	Annular	?
Cranial length	-	180*	-
Cranial breadth	152*	-	-
Minimum frontal breadth	96*	89*	96
Upper facial height	67*	-	69
Orbital height (right)	35*	-	36
Orbital breadth (right)	-	-	40
Nasal height	-	-	53
Nasal breadth	-	-	22
Alveolar length	54*	55*	53*
Alveolar breadth	59*	65*	69
Orbital index	-	-	90.0
Nasal index	-	-	41.5
Maxillo-alveolar index	109.3	118.2	130.2

*Slight damage at point of measurement.

The orbital index described for 1T1C6/1T1C7 indicates a hypsiconchic, or high and narrow orbit. It corresponds to previously

derived male and female averages of the Nootka, averages that are exceeded on the British Columbia coast only by the Southern Kwakiutl. The nasal index of 41.5 is in the lower leptorrhine range of description, which denotes an extremely narrow nasal skeleton.

Non-Metric Morphology

Relative differences in the frequency of non-metric variants were previously found to be of value in detecting biological differences among local groups of the British Columbia coast (Cybulski 1972). There is some question, however, whether the expression of some variants may be influenced by artificial head deformation (Ossenberg 1970). Observed variations in the Yuquot remains are recorded in Table 2. All available cranial materials in the midden are included. Sample sizes for bilateral observations are based on the sum of both right and left sides.

The very small sample sizes for these data obviously preclude significant inferences. It is worth mentioning, however, that the incidence of parietal foramen absence of 62.5% for the eight observations is unusually high relative to other Nootka local samples that have been studied. The frequency for each of three samples did not exceed 33.3% and this figure is generally constant for local samples throughout Vancouver Island, including those of the Kwakiutl and Coast Salish.

Table 2. Incidence of Cranial Variations

Variant	Frequency	Per cent
Tympanic dehiscence	3/9	33.3
Parietal foramen absent	5/8	62.5
Marginal zygomatic tubercle	6/7	85.7
Malar tuberrosity	1/7	14.3
Zygomaxillary tubercle	4/6	66.7
Subnasal margin indistinct	6/6	100.0
Supraorbital foramen	3/6	50.0
2 zygomaticofacial foramina	2/4	50.0
Hypoglossal canal spur	1/3	33.3
Condyloid canal absent	1/2	50.0
Sagittal sinus common	1/2	50.0
Palatine suture anterior	1/2	50.0
Palatine suture straight	1/2	50.0
Lambdic ossicle	1/2	50.0
Lambdoidal wormians	1/1	100.0

The occurrence of a case of lambdic ossicle in but two observations is also of interest. This variant was found to occur previously in only 2.1% of 48 Nootka skulls.

Permitted observations for variants other than those listed in Table 2 yielded negative results. Among those of largest sample size are supraorbital (frontal) grooves (n = 0), auditory exostoses (n = 9), tympanic plate thickening (n = 9), and metopism (n = 6).

Mandible

Although no mandibles were associated with the skulls, two relatively complete mandibles and several fragments of additional lower jaws are available. Three adult symphysis height measurements provide values of 31, 34, and 35 mm. The latter two figures compare to a previously derived male Nootka average of 36.9 mm, whereas the former compares to a female Nootka average of 32.9 mm (personal notes). Minimum breadth measurements for two left rami furnish values of 39 and 40 mm. The figures compare to a male Nootka average of 40.2 mm. No other mandibular measurements were possible.

Three specimens reveal a chin form of the median type and a fourth reveals the medio-bilateral type. There were no occurrences of multiple mental foramina in nine total side observations and no occurrences of mandibular torus in nine body halves. Multiple mental foramina are generally rare in Nootka mandibles, having been previously found in only 1 of 58 observations by this author. The mandibular torus was previously seen in 2 of 30 mandibles.

Postcranial Morphology

The amount of morphological data that could be extracted from the postcranial remains is minimal and less than that afforded by the cranial materials. Only three long bones were sufficiently intact to provide length measurements. The values are reported in Table 3 along with the head diameters of two humeri and three radii, and the subtrochanteric diameters of three femoral shafts. All three platymeric indices derived from the subtrochanteric diameters are within the range of hyperplatymeria, the descriptive category that denotes extreme antero-posterior flattening of the femoral shafts. The single humerus length yields a stature estimate of 167.07 $\pm$ 4.25 cm, according to the method of Trotter and Gleser (1958); the radius length provides an estimate of 164.13 $\pm$ 4.60 cm. Judging from their locations in the midden, the two bones may represent two different individuals. Both estimates reflect statures of approximately 5 ft., 5 in.

The right sides of three cervical vertebrae were sufficiently preserved to allow observation on the numerical variation of transverse foramina. One bone, identified as 1T1C5, features a single perforation, whereas a second, identified as either 1T1C4 or 1T1C5, features a double perforation. There is a single perforation in an immature axis. The only other variation in cervical vertebrae is the occurrence of spina bifida in a mature axis.

There are no cases of supratrochlear spur or septal aperture in four mature humeri and none of six radii have biceptal spurring. The "third trochanter," a conical projection on the gluteal ridge, is present in one of three femoral shafts.

Table 3. Adult Postcranial Measurements (mm)

Character	1T1C7 (Right)	1T1C7 (Left)	1T3B10 (Right)	1T1N5 (Left)	1T1E10 (Left)	1T1X1 (Right)	1T1X1 (Left)
Clavicle length	126	-	-	-	-	-	-
Humerus length	-	313	-	-	-	-	-
Humerus head-max. diam.	37	43	-	-	-	-	-
Humerus head-min. diam.	35	42	-	-	-	-	-
Radius length	-	-	232	-	-	-	-
Radius head-transv. diam.	-	-	23	21	22	-	-
Femur shaft-subtroch. diam., ant.-post.	-	21	-	-	-	25	21
Femur shaft-subtroch. diam., med.-lat.	-	35	-	-	-	35	30
Platymeric index	-	60.0	-	-	-	71.4	70.0

Dentition

The alveoli of mature jaws and the available teeth in the collection were examined for evidence of dental pathology, including abscess formation, degree of tooth wear, carious lesions, and cusp fractures. Most of the jaw fragments lacked teeth at one or more sites. In no case, however, is there evidence of premortem loss. The incidence of postmortem tooth loss is 70.2% in the upper jaws (84 sites) and 55.2% in the lower jaws (67 sites).

There are signs of alveolar abscess formation at 11 of a total of 129 observable tooth sites (8.5%). Six of 76 maxilla sockets and five of 53 mandible sockets are affected. Four of the maxilla cases had occurred at first molar sites and the remainder at canine sites. In the lower jaws, two cases had taken place at first molar sites and three at second molar sites.

None of 66 observable teeth have caries, but premortem cusp fractures are visible in three teeth. The exact incidence of cusp fractures is unknown, however, as in most instances occlusal attrition or postmortem damage obscures observation.

Tooth wear was graded on a scale of 0-5: 0-no wear, 1-cusps blunted, 2-dentin visible, 3-cusps gone, 4-secondary dentin formation, and 5-roots functional and/or pulp chambers exposed. Opened pulp chambers are not evident. In several instances, however, crowns are completely worn away leaving the roots functional. Such occurrences are more frequent in the mandibular than in the maxillary teeth. This feature is evident in the average state of attrition based on first permanent molars. The overall average is 3.2, that of the mandible is 4.1, and that of the maxilla is 2.3.

Aspects of dental pathology can often be related to dietary patterns. The dental patterns revealed by the Yuquot remains - that is, no caries, evidence of cusp fractures, and a tendency toward advanced attrition - are generally indicative of a coarse "hunting and gathering" type of diet with little or no carbohydrate content.

Because of occlusal wear and postmortem crown damage, observations on tooth morphology are minimal. Maxillary incisors are invariably shovel-shaped. Of 23 molars, 15 display extensions of enamel onto roots. The incidence is greater in upper than in lower molars (81.8 and 50.0% respectively).

Three anomalous variations can be cited. The first permanent molar of a right mandibular fragment (2A22) has three rather than the usual two roots. The extra root is positioned lingually and is smaller and thinner than the others. In an upper right second molar, the mesio-buccal and lingual roots are connected by a sheet of cementum. The third anomaly is illustrated in Fig. 3. The unerupted canine of an immature left maxilla is inverted within its crypt.

Fig. 3. Immature left maxilla with inverted unerupted canine.

Skeletal Pathology

Eight specimens in the collection show osteoarthritic changes at joint surfaces. These include two of six radial heads and one of five temporo-mandibular fossae. The last occurrence is associated with the Burial 1T1C6 skull. Advanced changes had occurred on two specimens. An atlas fragment (the only one in the sample) has extensive plaque and eburnation on the dens facet. An eburnated surface also characterizes the capitulum of one of the right humeri of Burial 1T1C6/1T1C7. The trochlea of this bone and that of the left humerus in Burial 1T1C6/1T1C7 are pitted. Osteoarthritic changes are also visible on the left inferior articular facet of an axis and on the distal articular surface of a proximal phalange.

The only other instances of bone pathology, aside from the alveolar abscesses reported in the previous section, involve two cranial fragments. A fragment of immature parietal bone displays osteoporosis along a part of the lambdoidal suture area. Similar lesions are evident along the midline of an incomplete but apparently mature frontal bone.

Summary

The human remains recovered from Yuquot in 1966 are fragmentary and few in number. Resultant osteological findings should thus be regarded with caution from the standpoint of inferences about the earlier population of the area. The following salient features of the collection may be summarized as follows:

1. At least nine people are represented: six adults and three children. The adults include two identifiable females and possibly two males.

2. The two most complete skulls were artificially deformed. One was deformed in annular fashion, as was the custom among the Northern and Central Nootkan groups, and the other was deformed by means of antero-posterior pressure. Antero-posterior deformation was ethnically foreign to the area and its presence in the collection leads to the suspicion that the Yuquot sample cannot be regarded as truly representative of a viable population unit.

3. Cranial morphology reveals a wide range of variation in three maxillo-alveolar indices and a high incidence of parietal foramen absence. The incidence of this variant is twice that of previously studied local samples of early historic populations of Vancouver Island. On the other hand, absence of multiple mental foramina and mandibular torus in Yuquot bones is commensurate with a low incidence of these variants in early historic Nootka.

4. Three measurable femoral shafts all reveal hyperplatymeria. Stature estimates from two long bone lengths approximate 5 ft., 5 in.

5. Dental pathology reveals no caries, evidence of premortem cusp fractures, and a tendency to advanced occlusal attrition. Such patterns are generally indicative of a coarse "hunting and gathering" type of diet with little or no carbohydrate content.

6. Instances of bone pathology include degenerative joint disease and osteoporosis in two cranial fragments.

It should, perhaps, be emphasized that the inferred heterogeneity of the Yuquot sample, postulated from the presence of two ethnically different forms of head deformation, should not be interpreted as a possible reflection of temporal discontinuity in the series, either of a cultural or biological nature. Nor should it be interpreted as a possible indication of biological heterogeneity in a contemporaneous population unit. There is no evidence in the archaeological context of the skulls to conclude that they are of two different time periods. Field notes indicate that both skulls are of the early historic period.

With respect to a possible inference of biological heterogeneity within a contemporaneous population unit, it should be remembered that the differences in head form do not represent differences in physical type, but, rather, differences in cultural practice. Whether there is variation within the sample that might reflect biological heterogeneity

cannot be determined from the limited bone materials. In this respect, more certain osteological inferences about the early Yuquot people and detailed comparisons with other early Northwest Coast populations must await additional sampling from the Yuquot area.

References Cited

Barnett, Homer G. 1955. The Coast Salish of British Columbia. University of Oregon Monographs, Studies in Anthropology 4. Eugene.

Boas, Franz. 1889. Deformation of Heads in British Columbia. Science, Vol. 13, pp. 364-65.

---. 1891. Second General Report on the Indians of British Columbia. Report of the British Association for the Advancement of Science, 1890, pp. 562-715.

Cybulski, Jerome S. 1972. Skeletal Variability in British Columbia Coastal Populations: A Descriptive and Comparative Assessment of Cranial Morphology. Ph.D. thesis, University of Toronto.

Dewhirst, John T. 1969. Yuquot, British Columbia: The Prehistory and History of a Nootkan Village. Part 2. Prehistory. Northwest Anthropological Research Notes, Vol. 2, No. 2, pp. 232-39.

---. 1980. The Indigenous Archaeology of Yuquot, a Nootkan Outside Village. National Historic Parks and Sites Branch, Parks Canada, Ottawa. (History and Archaeology series, No. 39, The Yuquot Project, Vol. 1.)

Drucker, Philip. 1951. The Northern and Central Nootkan Tribes. Bureau of American Ethnology, Bulletin 144. Washington.

Folan, William J. 1969. Yuquot, British Columbia: The Prehistory and History of a Nootkan Village. Part 1. Introduction and Ethnohistory of the Village. Northwest Anthropological Research Notes, Vol. 3, No. 2, pp. 217-31.

Folan, William J. and John T. Dewhirst. 1970. Yuquot: Where the Wind Blows from All Directions. Archaeology, Vol. 23, No. 4, pp. 276-86. New York.

Montagu, M.F. Ashley. 1960. An Introduction to Physical Anthropology. 3rd ed. C.C. Thomas, Springfield.

Ossenberg, Nancy S. 1970. The Influence of Artificial Cranial Deformation on Discontinuous Morphological Traits. American Journal of Physical Anthropology, Vol. 33, pp. 357-72.

Trotter, Mildred and G.C. Gleser. 1958. A Re-Evaluation of Estimation of Stature Based on Measurements of Stature Taken during Life and of Long Bones After Death. American Journal of Physical Anthropology, n.s., Vol. 16, pp. 79-123.

HISTORY AND ARCHAEOLOGY/HISTOIRE ET ARCHEOLOGIE

Publications available in Canada through authorized bookstore agents and other bookstores, or by mail from the Canadian Government Publishing Centre, Supply and Services Canada, Hull, Quebec, Canada K1A 0S9.

1 **Geneviève G. Bastien, Doris D. Dubé and Christina Southam,** Inventaire des marchés de construction des archives civiles de Québec, 1800-1870
(1975; 3 vols.; $20.00 a set, $24.00 outside Canada. Technical reference work available in French in the **Histoire et archéologie** series.)

2 **Réal Bélanger,** Social and Economic History of St-Lin, 1805-83, and the Importance of the Laurier Family
(1980; $4.00, $4.80 outside Canada)

3 **Yvon Desloges,** Structural History of Fort George
(1980; $5.00, $6.00 outside Canada)

4 **André Giroux, Nicole Cloutier and Rodrigue Bédard,** Plans de l'architecture domestique inventoriés aux Archives Nationales du Québec à Montréal; Plans de l'architecture commerciale et industrielle inventoriés aux Archives Nationales du Québec à Montréal; Plans de l'architecture publique, de l'architecture religieuse et du génie mécanique inventoriés aux Archives Nationales du Québec à Montréal
(1975; 3 vols.; $11.00 a set, $13.20 outside Canada. Technical reference work available in French in the **Histoire et archéologie** series.)

5 **E.Y. Arima,** A Report on a West Coast Whaling Canoe Reconstructed at Port Renfrew, B.C.
(1975; $5.50, $6.50 outside Canada)

6 **Olive Patricia Dickason,** Louisbourg and the Indians: A Study in Imperial Race Relations, 1713-1760
Linda M. Hoad, Surgeons and Surgery in Ile Royale
(1976; out of print)

7 **Norman F. and Anne Barka,** Archaeology and the Fur Trade: The Excavation of Sturgeon Fort, Saskatchewan
(1976; $6.25, $7.50 outside Canada)

8 **David Flemming,** Navy Hall, Niagara-on-the-Lake
David Lee, Fort Wellington: A Structural History
David Lee, The Battle of the Windmill: November 1838
(1976; $5.75, $6.90 outside Canada)

9 **John P. Wilson and Linda Southwood,** Fort George on the Niagara: An Archaeological Perspective
(1976; $8.00, $9.60 outside Canada)

10 Réal Boissonnault, Jacques Cartier: His Life and Exploits (1491-1557)
Kenneth E. Kidd, Excavations at Cartier-Brébeuf Park, Quebec City, 1959
John H. Rick, Excavations at Cartier-Brébeuf Park, Quebec City, 1962
Marcel Moussette, Salvage Excavations at Cartier-Brébeuf Park, Quebec City, 1969
(1980; $9.00, $10.80 outside Canada)

11 Iain C. Walker, Clay Tobacco-Pipes, with Particular Reference to the Bristol Industry
(1977; 4 vols.; $25.00 a set, $30.00 outside Canada)

12 Richard Lueger, Prehistoric Occupations at Coteau-du-Lac, Quebec: A Mixed Assemblage of Archaic and Woodland Artifacts
A. Couture and J.O. Edwards, Analyses of Two Prehistoric Copper Artifacts from the Cloverleaf Bastion of the Fort at Coteau-du-Lac, Quebec
D.E. Lawrence, Identification of Representative Prehistoric Stone Artifacts and Samples of Unworked Stone from the Cloverleaf Bastion of the Fort at Coteau-du-Lac, Quebec
W.B. Scott, Fish Remains from the Cloverleaf Bastion of the Fort at Coteau-du-Lac, Quebec
J. Edson Way, The Human Osteological Material from the Cloverleaf Bastion of the Fort at Coteau-du-Lac, Quebec
(1977; $8.00, $9.60 outside Canada)

13 Margaret Coleman, The American Capture of Fort George, Ontario
Elizabeth Vincent, The Guardhouse at Fort George, Ontario
(1977; out of print)

14 J.N. Emerson, H.E. Devereux and M.J. Ashworth, A Study of Fort St. Joseph
(1977; $9.50, $11.40 outside Canada)

15 Karen Price, Glimpses of Soldiering at Coteau-du-Lac, Quebec - 1780 to 1856
Karlis Karklins, Beads from the Fort at Coteau-du-Lac, Quebec
Paul McNally, Table Glass from the Fort at Coteau-du-Lac, Quebec
Ann Cunningham Falvey, Coins from the Fort at Coteau-du-Lac, Quebec
(1977; $8.25, $9.90 outside Canada)

16 Roger T. Grange, Jr., Cumulative Seriation and Ceramic Formula Dating: A Preliminary Study
(1977; $4.25, $5.10 outside Canada)

17 Doris Drolet Dubé and Marthe Lacombe, Inventaire des marchés de construction des Archives nationales à Québec, XVII^{e} et XVIII^{e} siècles
(1977; $8.00, $9.60 outside Canada. Technical reference work available in French in the Histoire et archéologie series.)

18 **Roger T. Grange, Jr.**, Early Fortification Ditches at Ile-aux-Noix, Quebec
(1977; 2 vols.; $5.50 a set, $6.60 outside Canada)

19 **Roger T. Grange, Jr.**, Excavation of the Porter's Cottage, Civilian Barracks/Straw Shed, Northern Mounds and Rampart at Fort Lennox National Historic Park, 1966
(1978; $5.50, $6.60 outside Canada)

20 **Norman F. Barka**, The Archaeology of Fort Lennox, Ile-aux-Noix, Quebec, 1964 Season
Karlis Karklins, The Beads from Fort Lennox, Quebec
(1978; $7.75, $9.30 outside Canada)

21 **Peter J. Priess**, An Annotated Bibliography for the Study of Building Hardware
(1976; $2.75, $3.30 outside Canada)

22 **Marcel Moussette**, Fishing Methods Used in the St. Lawrence River and Gulf
(1979; $6.75, $8.10 outside Canada)

23 **Claudette Lacelle**, The British Garrison in Quebec City as Described in Newspapers from 1764 to 1840
(1979; $4.50, $5.40 outside Canada)

24 **Lynne Sussman**, The Ceramics of Lower Fort Garry: Operations 1 to 31
(1979; $8.00, $9.60 outside Canada)

25 **Peter J. Priess**, A Study of Surface-Mounted Door Locks from a Number of Archaeological Sites in Canada
Robert J. Burns, Inverarden: Retirement Home of Fur Trader John McDonald of Garth
(1979; $8.00, $9.60 outside Canada)

26 **Jean-Pierre Proulx**, The Military History of Placentia: A Study of the French Fortifications
Jean-Pierre Proulx, Placentia: 1713-1811
(1979; $8.00, $9.60 outside Canada)

27 **Jeanne Alyluia**, Nineteenth-Century Glassware from the Roma Site, Prince Edward Island
Barbara J. Wade, Cutlery from the Roma Site, Prince Edward Island
(1979; $7.25, $8.70 outside Canada)

28 **Allan Greer**, The Soldiers of Isle Royale
(1979; $5.00, $6.00 outside Canada)

29 **Paul McNally**, French Table Glass from the Fortress of Louisbourg, Nova Scotia
Jane E. Harris, Eighteenth-Century French Blue-Green Bottles from the Fortress of Louisbourg, Nova Scotia
(1979; $7.50, $9.00 outside Canada)

30 **Kenneth E. Kidd**, Glass Bead-Making from the Middle Ages to the Early 19th Century
(1979; $5.00, $6.00 outside Canada)

31 **Geneviève Guimont Bastien, Line Chabot, Doris Drolet Dubé**, Inventaire des dessins architecturaux aux archives de l'université Laval
(1980; $20.00, $24.00 outside Canada. Technical reference work available in French in the **Histoire et archéologie** series.)

32 **Robert Caron**, Inventaire des permis de construction des archives de la ville de Québec, 1913-1930
(1980; 3 vols.; $40.00 a set, $48.00 outside Canada. Technical reference work available in French in the **Histoire et archéologie** series.)

33 **Christine Chartré, Jacques Guimont, Pierre Rancour**, Répertoire des marchés de construction et des actes de société des Archives nationales du Québec à Trois-Rivières, de 1760 à 1825
(1980; $13.25, $15.90 outside Canada. Technical reference work available in French in the **Histoire et archéologie** series.)

34 **Christine Chartré, Jacques Guimont, Pierre Rancour**, Répertoire des inventaires et des inventaires après décès des Archives nationales du Québec à Trois-Rivières, de 1760 à 1825
(1980; $23.25, $27.90 outside Canada. Technical reference work available in French in the **Histoire et archéologie** series.)

35 **Roger T. Grange, Jr.**, Mr. Thomas McVey's Dwelling House: A Residence on Ile aux Noix, Quebec
(1980; $8.95, $10.75 outside Canada)

36 **Roger T. Grange, Jr.**, Excavation of the Right Redoubt and Blockhouse, British Fortifications at Ile aux Noix, Quebec
(Forthcoming)

37 **David Flemming**, Fort Mississauga, Ontario (1814-1972)
(Forthcoming)

38 **Gérard Gusset**, Stoneware: White Salt-Glazed, Rhenish and Dry Body
(1980; $13.50, $16.20 outside Canada)

39 The Yuquot Project, Vol. 1
John Dewhirst, The Indigenous Archaeology of Yuquot, a Nootkan Outside Village
(1980; $15.00, $18.00 outside Canada)

40 **William Beahen**, Development of the Severn River and Big Chute Lock Station
(1980; $5.25, $6.30 outside Canada)

41 **Roch Samson**, Fishing at Grande-Grave in the Early 1900s
(1980; $6.75, $8.10 outside Canada)

42 **Louise Trottier**, Les Forges du Saint-Maurice: Their Historiography
(1980; $11.00, $13.20 outside Canada)

43 The Yuquot Project, Vol. 2
J.E. Muller, Geological Outline of the Nootka Sound Region, with Notes on Stone Artifacts from Yuquot, British Columbia
J.A. Donaldson, Lithology of Stone Artifacts and Associated Rock Fragments from the Yuquot Site
Anne M. Rick, Identification and Biological Notes on Selected Bone and Tooth Artifacts from Yuquot, British Columbia
Louise R. Clarke and Arthur H. Clarke, Zooarcheological Analysis of Barnacle Remains from Yuquot, British Columbia
Judith A. Fournier and John Dewhirst, Zooarchaeological Analysis of Barnacle Remains from Yuquot, British Columbia
Nancy M. McAllister, Avian Fauna from the Yuquot Excavation
Jerome S. Cybulski, Osteology of the Human Remains from Yuquot, British Columbia
(1980; $11.25, $13.50 outside Canada)

CANADIAN HISTORIC SITES
OCCASIONAL PAPERS IN ARCHAEOLOGY AND HISTORY

This series is also available in Canada through authorized bookstore agents and other bookstores, or by mail from the Canadian Government Publishing Centre, Supply and Services Canada, Hull, Quebec, Canada K1A 0S9.

1 **John H. Rick**, Archaeological Investigations of the National Historic Sites Service, 1962-1966
K.E. and M.A. Kidd, A Classification System for Glass Beads for the Use of Field Archaeologists
Margaret Coleman, The Roma Settlement at Brudenell Point, Prince Edward Island
(1974; $4.00, $4.80 outside Canada; reprint)

2 Contributions from the Fortress of Louisbourg - No. 1
Edward McM. Larrabee, Archaeological Research at the Fortress of Louisbourg, 1961-1965
Bruce W. Fry, A "Rescue Excavation" at the Princess Half-Bastion, Fortress of Louisbourg
Iain C. Walker, An Archaeological Study of Clay Pipes from the King's Bastion, Fortress of Louisbourg
(1976; $4.00, $4.80 outside Canada; reprint)

3 **Charles E. Cleland**, Comparisons of the Faunal Remains from French and British Refuse Pits at Fort Michilimackinac: A Study in Changing Subsistence Pattern
David Lee, The French in Gaspé, 1534 to 1760
Walter A. Kenyon, The Armstrong Mound on Rainy River, Ontario
(1970; out of print)

4 **Dale Miquelon**, A Brief History of Lower Fort Garry
George C. Ingram, The Big House, Lower Fort Garry
George C. Ingram, Industrial and Agricultural Activities at Lower Fort Garry
William R. Morrison, The Sixth Regiment of Foot at Fort Garry
William R. Morrison, The Second Battalion, Quebec Rifles, at Lower Fort Garry
(1975; $4.00, $4.80 outside Canada; reprint)

5 **James V. Chism**, Excavations at Lower Fort Garry, 1965-1967; A General Description of Excavations and Preliminary Discussions
(1972; out of print)

6 **Hugh A. Dempsey**, A History of Rocky Mountain House
William C. Noble, The Excavation and Historical Identification of Rocky Mountain House
(1973; out of print)

7 **Edward B. Jelks**, Archaeological Investigations at Signal Hill, Newfoundland, 1965-66
(1973; $3.00, $3.60 outside Canada)

8 John P. Heisler, The Canals of Canada
(1973; out of print)

9 Edward F. Bush, The Canadian Lighthouse
Paul McNally, Table Glass Excavated at Fort Amherst, Prince Edward Island
Susan Buggey, Halifax Waterfront Buildings: A Historical Report
(1974; $7.75, $9.30 outside Canada)

10 Barbara A. Humphreys, The Architectural Heritage of the Rideau Corridor
Jane E. Harris, Glassware Excavated at Fort Gaspereau, New Brunswick
Edward F. Bush, Commissioners of the Yukon, 1897-1918
(1974; out of print)

11 Carol Whitfield, The Battle of Queenston Heights
Robert S. Allen, A History of Fort George, Upper Canada
Victor J.H. Suthren, The Battle of Châteauguay
(1974, $5.00, $6.00 outside Canada)

12 Contributions from the Fortress of Louisbourg - No. 2
Charles S. Lindsay, Lime Preparation at 18th-Century Louisbourg
Charles S. Lindsay, Louisbourg Guardhouses
T.M. Hamilton and Bruce W. Fry, A Survey of Louisbourg Gunflints
(1975; $5.00, $6.00 outside Canada)

13 Hilary Russell, All That Glitters: A Memorial to Ottawa's Capitol Theatre and Its Predecessors
Jane E. Harris, Glassware Excavated at Beaubassin, Nova Scotia
Carol Whitfield, Sir Sam Hughes (1853-1921)
(1975; $6.50, $7.80 outside Canada)

14 Robert S. Allen, The British Indian Department and the Frontier in North America, 1755-1830
G.E. Mills and D.W. Holdsworth, The B.C. Mills Prefabricated System: The Emergence of Ready-Made Buildings in Western Canada
(1975; $5.75, $6.90 outside Canada)

15 Ivan J. Saunders, A History of Martello Towers in the Defence of British North America, 1796-1871
Donald A. Harris, Report of the 1972 Archaeological Excavations of the Market Shoal Tower, Kingston, Ontario
(1976; $6.75, $8.10 outside Canada)

16 Judith Beattie and Bernard Pothier, The Battle of the Restigouche
Paul McNally, Table Glass from the Wreck of the Machault
K.J. Barton, The Western European Coarse Earthenwares from the Wreck of the Machault
William Naftel, The Cochrane Ranch
(1977; $5.00, $6.00 outside Canada)

17 **John Joseph Greenough**, The Halifax Citadel, 1825-60: A Narrative and Structural History
(1977; $6.00, $7.20 outside Canada)

18 Contributions from the Fortress of Louisbourg - No. 3
Raymond F. Baker, A Campaign of Amateurs: The Siege of Louisbourg, 1745
Blaine Adams, The Construction and Occupation of the Barracks of the King's Bastion at Louisbourg
(1978; $6.50, $7.80 outside Canada)

19 **Gordon Bennett**, Yukon Transportation: A History
(1978; $6.50, $7.80 outside Canada)

20 **Mary K. Cullen**, The History of Fort Langley, 1827-96
L.G. Thomas, Ranch Houses of the Alberta Foothills
(1979; $6.50, $7.70 outside Canada)

21 **Philip Goldring**, The First Contingent: The North-West Mounted Police, 1873-74
Philip Goldring, Whisky, Horses and Death: The Cypress Hills Massacre and its Sequel
Edward F. Bush, The Dawson Daily News: Journalism in the Klondike
(1979; $6.50, $7.80 outside Canada)

22 **Lynne Sussman**, Spode/Copeland Transfer-Printed Patterns Found at 20 Hudson's Bay Company Sites
(1979; $10.00, $12.00 outside Canada)

23 **Richard J. Young**, Blockhouses in Canada, 1749-1841: A Comparative Report and Catalogue
David Lee, Gaspé, 1760-1867
(1980; $10.00, $12.00 outside Canada)

24 **Christina Cameron and Janet Wright**, Second Empire Style in Canadian Architecture
(1980; $10.00, $12.00 outside Canada)

25 **Mathilde Brosseau**, Gothic Revival in Canadian Architecture
(1980, $10.00, $12.00 outside Canada)